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JOURNAL OF MAMMALOGY

VOL. 18 AUGUST, 1937 NO. 3

AMERICAN SOCIETY OF MAMMALOGISTS

ALLEN MEMORIAL NUMBER

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Incorporated April 29, 1920

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The Journal of Mammalogy

Subscription rates, $4.00 per year; single numbers $1.00 each. Sent free to all members of the American Society of Mammalogists not in arrears for dues.

Subscriptions, changes of addresses, requests for missing numbers, applications for advertising rates, etc., should be sent to the corresponding secretary, William H. Burt, Museum of Zoology, University of Michigan, Ann Arbor, Mich.

Manuscripts for publication, books and papers for notice and reviews, etc., should be sent to A. Brazier Howell, Department of Anatomy, Johns Hopkins Medical School, Baltimore, Md.

Entered as second-class matter November 22, 1919, at the Postoffice, Baltimore, Md., under the act of March 3, 1879

Made in United States of America

JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 18 AUGUST 14, 1937 No. 3

THE MALAYAN GAUR OR SELADANG

BY THEODORE R. HUBBACK

The variety of gaur (*Bibos gaurus hubbacki*) found in the Malay Peninsula was designated a subspecies by Lydekker in 1907, who gave the following reasons for naming it in his book, "The Game Animals of India, Burma, Malaya, and Tibet":

"If the pyoung, or Burmese gaur, is separated from the Indian animal, there can be no reasonable doubt that the seladang, or Malay representative of the species, is likewise entitled to similar rank. This probability is converted to a certainty by the distinctive features presented by three adult bull seladang heads recently sent to London by Mr. T. R. Hubback, author of *Elephant and Seladang Hunting in Malaya*, London, 1904. In that work Mr. Hubback himself states that in adult seladang there is no dewlap, and the colour of the "stockings" is dirty yellow. The heads just referred to show that the seladang has a much smaller development of the ridge between the horns than the Indian gaur, a greater extent of tawny on the forehead, and also a distinct whitish band above the muzzle. In one of the heads there is a fair development of the intercornual ridge, but in the other two the line between the horns is quite straight; in fact, if it were not for the horns, which are of the characteristic gaur type, these two heads might almost be referred to as gayal. They render it practically certain that the latter is not specifically distinct from the gaur; and it is significant in this connection that the one supposed specimen of a wild gayal was killed in Tenasserim.

"The seladang may be named *Bos gaurus hubbacki*; a specimen presented by Mr. Hubback to the British Museum being taken as the type."

This description, as I shall show later, is not quite accurate regarding the absence of a dewlap; in fact, if such a character be taken as a basis for the making of subspecies it is possible that there may be two forms of gaur in Malaya.

The seladang calves are of a bright golden bay color but it is possible that

this shade does not develop its full brilliancy until the calf is a few weeks old. Regarding this point I am not very certain, although I have seen very small calves that were mouse-colored instead of the golden bay that I would have expected.

As soon as the calves are about one month old they invariably show this golden bay color and are very conspicuous in the jungle. I have referred to this point later on. I think that the bay color lasts for about 5 or 6 months and then the color of the body, and the legs to the knees and hocks, gradually changes to a dark sepia, with light stockings and a light forehead. In most cases there are lightish patches of hair above the bare part of the nose, around the lips, and under the chin. Figure 1 is of a young seladang bull probably about 12 months old. This animal, which was within 30 yards of me for a considerable time, was quite dark in color. In fact, one might describe it as being dark sepia, but its legs from the knees and hocks downward were of a very light khaki color; the frontlet, as is shown in the photograph, was a grayish yellow.

These colors last throughout life, except that as the age of the animal increases the body becomes darker, and in very old animals the frontlet becomes gray. Also in mature bulls it is commoner to see dark khaki stockings than the light ones that are characteristic of calves and cows. The mature bull seladang is a magnificent animal measuring up to six feet three and one-half inches at the shoulder, with a length from nose to rump of between 9 and 10 feet. As the illustrations here show, it is an animal of enormous strength and great bulk, and although I have no figures to support my estimate, I do not think that a big bull seladang would weigh less than 2000 pounds. The cows are of lighter build, but are little less in stature than the bulls, and an old cow measuring five feet ten inches at the shoulder is by no means uncommon.

There appear to be two distinct phases of development of the dewlap in the seladang. In some cases, mature seladang have a very pronounced dewlap; in other cases it is hardly developed at all. I have found that seladang with heavy dewlaps are generally taller than those with little or no dewlap, have longer horns, and have more light hair around the muzzle. Those with little or no dewlap are generally stockily built, but less in shoulder measurement; and although the light patch on the chin seems to be common to all seladang, those without a developed dewlap seldom have any light patch over the nose. This applies to cows as well as bulls, but the dewlap is never well developed in the former.

It is possible that there are two subspecies of seladang in Malaya, but I have insufficient information to enable me to express a definite opinion on the subject. The bare portion of the nose is generally dark gray, sometimes almost black, but is never pink as is sometimes found in the Indian gaur. The glory of a bull seladang's horns when in his prime and before the tips

have become much worn, is one of nature's triumphs. The young seladang has horns yellow at the base with longish black points; as the animals get older the bases thicken and become corrugated, changing color to a deep olive green. This statement applies to the horns of cows as well as of bulls, although the former never approach those of the bulls in length or girth. A cow's horns very seldom reach a basal diameter of 15 inches, while in bulls they sometimes attain 22 inches or more. The Malayan animal, as a rule, does not have long or wide-spreading horns, due possibly to the dense jungle in which it spends most of its time. An outside spread of 40 and a length of 35 inches is seldom attained. I hesitate to estimate the age of a really old seladang, but, presuming that adolescence is reached during the fifth year, extreme old age would be at about the thirtieth year. I have known of old bull seladang that frequented certain tracts of country for many years, and this leads me to believe that these animals have a long life.

Seladang never wallow in mud baths so beloved by the Indian buffalo (*Bubalus bubalis*). As a result they always appear, except in the case of very old animals, as though they had just been groomed. Their hides shine with a luster that is most attractive. This is due to the fact that seladang secrete an oily exudation that carries with it a brown pigment, especially noticeable if they are wet from rain. When following seladang one is often warned of their proximity by a strong bovine scent, accentuated in the case of old bulls, and very noticeable if they have been put to much exertion, as after a long chase. An oldish animal, under such circumstances, will sweat so freely that a brown stain may be found on trees or saplings against which it has brushed, and the almost continuous scent left behind on the trees should not be allowed to mislead one into believing that the quarry is near. To any one experienced in bush-craft, the fresh odor of close proximity is distinguishable from the scent left on the trees.

The skin glands, or probably more particularly the sweat glands, of domestic cattle, including the zebu (*Bos indicus*), are not especially active, in contrast to those of *Bibos gaurus*. This characteristic may be of some phylogenetic value. The origin of the zebu is unknown, but was regarded by Blyth as probably African.

The word seladang is the Malayan name for the variety of gaur found in the Malay Peninsula, and is probably derived from two native words, *satu* meaning one and *ladang* meaning a jungle clearing, indicating that this animal is one that may be seen in a clearing; *satu ladang* is abbreviated to sladang or seladang. Other large Malayan mammals are not to be seen in such places; a rhinoceros, an elephant, or a tapir would not be found feeding in a clearing in the daytime.

The seladang is a forest-edge animal, and its habitat is not virgin forest, although it is frequently found in the forest due to circumstances forced upon it. It is unlikely that the seladang is an animal indigenous to the

Malay Peninsula. The following reasons seem to indicate a comparatively recent migration from the north. The entire peninsula, except the highest mountains, was originally covered with dense tropical virgin jungle; there were no natural clearings at all, and until man appeared from the north there would have been nothing approaching grass land except where possibly floods had cleared some river banks of vegetation. Even to this day no clearing remains free of jungle growth for more than a few months if left untended, and in two or three years it returns to a dense secondary forest. This is not the environment that would evolve a large species of the Bovidae, and it is reasonable to suppose that some centuries ago the seladang, or gaur as they were then called, came down through Siam and Burma to the Malay Peninsula, following the cleared spaces of the early settlers in Malaya. I advisedly write "settlers" because certain of the aborigines who inhabited the Malay Peninsula, and who still do so, make no clearings, merely living on roots, fruit, and anything that they can catch. Such races would not have helped to provide gaur with the grasses essential to their well-being and without which they would not be attracted to a new country. The origin of seladang in the Malay Peninsula is, I think, of the greatest importance when considering their habitat, environment and general reaction to those "civilizing" influences that are so perilous to their welfare, and for those reasons we must consider carefully the artificiality or naturalness of their present existence.

There is one extremely significant fact that points to a comparatively recent immigration to the Malay Peninsula, and that is the light color of the young seladang calves. I have given this subject much thought; I have made as careful observations as are possible on wild animals that can seldom be found except in dense cover; I have seen many scores of young seladang calves; and have drawn the following deductions. That seladang have not as yet adapted themselves completely from a physical standpoint to the environment in which they have to live in the peninsula, because a bright bay colored calf is not able to achieve that concealment in the forest, even when immobile, which nature generally contrives for the young of many species and for the adults of some species, as a protection against enemies. In grass country, which I think is the true habitat of *Bibos gaurus*, a light colored calf in times of danger would be well concealed when lying down or squatting, and it is this very habit of squatting when suddenly startled—not of course at very close quarters when panic would lead to flight—that seladang calves practise even in virgin jungle. I could give many instances but the following will suffice. I had disturbed a herd of 5 or 6 seladang on the edge of an old clearing that had grown up into a coarse rank grass called *lalang* (*Imperata arundinacea*). Among these seladang was a young calf of a bright golden bay color. We followed the herd and saw that the tracks of the calf were not there. We returned to the edge of the clearing, looking

FIG. 1

FIG. 2

Seladang at a salt lick. Fig. 1, a bull about one year old. Fig. 2, an old bull. (Photos. by Hubback, copyrighted.)

FIG. 3

FIG. 4

Seladang at a salt lick. Fig. 3, a cow and young bull seladang with a doe sambhur. Fig. 4, a small herd of seladang. (Photos. by Hubback, copyrighted.)

round about for the calf, but could see nothing. Presently one of my men spotted the calf on the edge of the jungle, looking towards us. Almost at once it disappeared from view, and I felt certain that it had squatted down for concealment. We walked slowly to where the calf had been and almost reached the edge of the jungle when the animal jumped up 5 or 6 yards from us and dived into the jungle. It sought safety in flight only when we were very close to it. The cows almost invariably leave the calves to take care of themselves on the assumption, I suppose, that immobility is a better safeguard for the calf than flight with the herd. I have never known a cow seladang to stand by her calf, but the calf will remain more or less in the same place until the mother returns for it, calling a soft low 'moo' until the calf hears it. I think it may often be hours before the cow returns, especially if much alarmed. These peculiar tactics of the seladang, not at all suitable to its environment in Malaya, no doubt account for a large mortality among the calves from tigers, who will certainly know, if I do, that a stampeded herd is likely to leave the calves behind. Here we have one factor against the seladang, owing to an incomplete adaption to a new environment.

In the Malay Peninsula, seladang herds are few and scattered and it is more than likely that the 10 or 12 animals in a herd very seldom meet any seladang from another herd. This fact causes one to suspect the danger of too much inbreeding, but I think nature has ways and means, which we seldom suspect, of overcoming such difficulties. It has seemed to me from long observation that there is a predominance of males in each herd. I advance this statement with some diffidence because it is difficult to tell the young bulls from the young cows and I may have been mistaken in my deductions. Another phase in the life history of the seladang is the frequent absence from the herd of quite young bulls, which leave for days or weeks, and then return to it. I do not entertain the view that these young solitary bulls have been driven away from the herd by a more powerful bull, which is what is generally supposed. I believe that seladang are naturally independent and that males are apt to go off by themselves at any time. I have seen quite young bulls, 3 or 4 years old, miles away from a herd. Such youngsters would not have been driven out of a herd. I have known of 3 young bulls, of which the oldest was not more than 5 years, well away from any others, thoroughly enjoying themselves in a salt lick. They certainly had not been forced out of a herd *en masse*, but were, I believe, merely following their natural inclination for wandering adventure. This proclivity to wander off by themselves may also help to check too close inbreeding, because young, middle aged, and old bulls all do it. Again old bulls are supposed to become entirely solitary, having been driven out from the herd to live a retired and morose existence. This I also do not believe, although a very old bull will be found more frequently by himself than with a herd. Still one finds very old bulls with herds, as figure 2 clearly shows. So it is more than likely that

the mature cows in a herd are not always served by the same bull, because even supposing that the master bull is the strongest one in the herd, his habit of going off by himself may at times coincide with a cow's desire for a mate, and some other bull in the herd may then be the sire of her next calf. Old bull seladang have a peculiar habit of attaching to them a young bull, often to be found in their company, several instances of which I have encountered. I have often thought that this 'attendant' is picked up to help an old bull to look after himself, because undoubtedly old bulls frequently become deaf and a companion can make up for their deficiency by acting as watchman. I once saw a case of a sambhur stag that had attached itself to an old bull seladang, but what constituted the attraction I do not know.

I believe that very old seladang whose strength has greatly decreased sometimes fall victims to tigers. I know at present of one old bull, obviously very nearly at the end of the trail, who is frequently attended by a very large tiger whose presence is decidedly not to the advantage of the seladang.

Seladang do not appear to have any special breeding season, calves being born at almost any time of the year. During the wettest months in Malaya, October to December, very young calves are seldom seen, although considering that the cows come in season not long after the calves are born, and that the gestation period is 9 months, there appears to be no reason why one month should be favored more than another. I think seladang cows seldom have more than one calf at a time, as I have never seen, except on one occasion, two calves following a cow. These exceptional calves were each about 12 months old, and only one of them may have belonged to the cow; the other may have lost its mother.

Seladang are extraordinarily sensitive to disturbance and will not thrive in country that is continually invaded by man. In Malaya this fact has accounted for their almost total disappearance from the west coast and from many places on the east coast. It is doubtful if 400 seladang exist in the Malay Peninsula, and of these at least 25 per cent, owing to isolated position, are certain to disappear in two or three decades. It is all the more necessary, therefore, to do our utmost to preserve intact those herds that are now in wilderness country. Unless great care is taken, seladang will be exterminated in Malaya. They are not mountain animals, and although in their many wanderings solitary bulls will go far into the mountain country, a herd does not do so, and land consisting of rolling terrain and river valleys must be preserved intact for their contentment. Therein lies the difficulty in Malaya, where, irrespective of true economic principles, the habitat of wild life is often ruined for some purely ephemeral benefit. National parks and reserves are the only hope of salvation for the seladang of Malaya, and I will deal with this aspect of the question later on.

The seladang is by no means voiceless. It has no less than 5 distinct and

characteristic methods of expressing its emotions. The one most commonly heard is the snort of alarm and surprise which is given by seladang when met at close quarters. This snort is made by a violent and rapid expulsion of air through the nostrils, and is one of the terrifying phenomenon referred to by Malays when describing the extreme ferocity of the seladang. This snort is supposed to precede an imminent attack and is immediately followed by flight on the part of the Malay, who on reaching his village describes with vivid detail how he was charged by a seladang and how only by his extreme agility was he able to save his life. What actually happens is that the seladang is terrified as well as the Malay—he probably could not be terrified as much—and the snort is immediately followed by a quick turn and precipitate flight.

The second sound made by the seladang is of the same class, but is made when a bull is explaining to the rest of the herd what a fine fellow he is, or when he is demonstrating to a tiger, which may be in the vicinity, that he is quite ready for a fight if the tiger comes within reach of his horns. These sounds are chiefly whistling snorts made through the nose as in the first instance, but are generally accompanied by the fighting of the undergrowth and by pawing up the ground. During these demonstrations seladang are apt to demolish ant hills with their horns, but this is sometimes due to attempts to remove ticks from their heads. This habit wears down the tips of the horns in some instances, although not invariably. I have obtained old seladang with perfect horn tips. It is, I think, a matter of temperament.

The third sound is that of a cow calling to her calf, which in most cases almost exactly duplicates the 'moo' of domestic cattle, but sometimes resembles a mild addition of the fourth sound, which I will presently describe. This noise is made only by a cow calling to a younger animal.

The fourth is the most peculiar sound made by seladang. It is a call to other seladang that may be in the vicinity and is beyond my powers to describe. It is a cross between the bugling of a wapiti (elk) and the trumpeting of an elephant. It is a melodious sound that carries a long way in the jungle. I have heard a young seladang calling in the jungle within a few chains of a salt lick, waiting to come into the lick but probably not wishing to enter it alone. It was in more or less the same position for about 2 hours and during that time it called four or five times. It had a fairly deep tone and I thought that it was a mature bull calling to the rest of the herd, but at the end of 2 hours, when it plucked up courage to come in by itself, it proved to be a young bull not more than two or three years of age.

The final variety of sound made by a seladang does, I believe, occur only once, and that is at the end of its life when it is dying a violent death. It is a dying moan which once heard will never be forgotten, and might be taken as a protest against the deprivation of its life while still strong and vigorous.

The main food of seladang consists of grasses, the one which they prefer

being known in the vernacular as *rumput chengkenit*. This is a creeping grass common throughout the Malay Peninsula and is cut a great deal for cattle food. *Lalang* and allied coarse grasses when young are also eaten by seladang. Clearings that are grown up to *lalang* are often burnt off to attract seladang. In the jungle they do not eat many of the leaves of jungle trees, but one tree of which they are very fond is the *merlimau* (*Atalantia monophylla*). The leaves of two trees that grow in secondary jungle, *mengkirai* (*Trema amboinensis*) and *beti-beti* (*Eugenia zeylanica*), are much liked by them. Seladang occasionally raid crops but never those that are properly cared for. They will eat young rice, which is of course like any other young succulent grass, and will also eat the leaves of young Indian corn, but as a potential danger to cultivation properly tended the seladang may be ignored. These animals are very fond of visiting salt licks, especially sulphur licks, and it is due to the fact that they will visit these licks during the day time that the accompanying photographs have been made possible. In the Malay Peninsula there are no open spaces in which one is in the least likely to find seladang during the brighter hours of the day, although one might occasionally see them in the early morning or evening. The sulphur or salt found in these licks is taken, I think, by seladang to rid their stomach of intestinal parasites. In some cases where seladang have visited a mud lick I have seen their droppings almost pure mud, and I think that these licks must be considered as the chemists' shops of these animals. In places where they are undisturbed, seladang are likely to visit a salt lick at any time of the day or night, but unfortunately such places in the Malay Peninsula are few and far between, and most visits to licks are made during the hours of darkness. For many decades when visiting salt licks seladang have been subject to gun fire by Malays safely ensconced in the shelter of high trees, with the result that such places are generally avoided during the hours of daylight. Even where there is no disturbance and the animals have a sense of security, the approach to a lick will be made with the greatest caution, and an animal about to enter a lick will generally wait at the edge of the jungle for some minutes before finally entering. Very old bulls are an exception to this rule because they do not seem to care for anybody or anything, and walk straight into the lick to have their drink, which may take them a long time, perhaps a quarter of an hour; and then they walk away without concern.

With two or three exceptions, no expert nor intelligent observations have ever been made on the ecology of the seladang. As a result, they have been judged by native gossip and have been credited with a ferocity and aggressiveness entirely foreign to their character. A big seladang if met in the jungle *looks* ferocious and has the same psychological effect on a native as had the horrible effigies on blatant banners carried in the van of an army, on Chinese soldiers in ancient days.

The seladang is in reality an exceptionally quiet and well-behaved wild

animal, timid to a degree so far as man is concerned and not, to my knowledge, intolerant of the presence of other animals. The illustration (fig. 3) of a doe sambhur (*Cervus unicolor*) in close proximity to a cow seladang and apparently unnoticed by a young bull seladang that has with great impoliteness turned his back on the doe, supports, to some extent, my contentions. In this case the doe sambhur came across my front—I was in a blind—and walked quietly to where these two seladang were drinking in a salt lick. Presently the seladang detected a slight taint in the wind and went off in a hurry, but this did not disturb the doe, although she immediately became suspicious and 'froze' into an expectant attitude that she maintained for quite a quarter of an hour. But that is another story.

I have often seen seladang and sambhur deer in this salt lick at the same time within 20 or 30 yards of each other, but only on this one occasion in such close proximity.

Bull seladang, of course, do fight at times. I have shot many seladang with new and old scars on them, but although, in my time, I have tracked them on foot for thousands of miles, I have never come across a single place where a fight had taken place. Signs of demonstrations I have frequently seen, but they appeared to lead to nothing in the way of active hostilities.

I know of only one authentic case of a bull seladang having been found dead after a fight with another bull, but I personally did not see the site of the affray.

Among the big game of Malaya, seladang, as a sporting animal, is in a class by itself. Although rhinoceros hunting may be more difficult, this animal is much less easy to obtain, and few Europeans have ever made any attempt to hunt rhinoceroses in the Malayan jungle. The seladang has been fairly widely distributed throughout Malaya and has been hunted a great deal at different times by both Europeans and natives. Unfortunately it is an animal that may occasionally be shot by waiting for it in the evening in a burnt-off clearing, or on some old estate where there is little disturbance and where these animals occasionally come out to feed. Seladang shot under such conditions are fired at in much the same way that one would shoot at a target, and trophies thus obtained in no way reflect any credit on the ability of the hunter. On the other hand, those who have tracked seladang in the jungle and have finally outwitted an animal that is especially alert when in dense jungle, will enjoy hunting and tracking equal to anything to be obtained elsewhere. As I have said already it is by no means certain that because an animal is solitary, it is therefore a desirable trophy, although it is unlikely that such an animal would be a cow. But any hunter after some experience soon gets to know the difference between the big track of a large young bull and the big track of a large old bull. Very often they are of much the same length, but they are not the same shape; the older track is wider at the heel, more blunt at the tip, and does not show an impression of

the outer edge of the hoof as seen in the younger track. This perhaps is scarcely the place in which to write a long dissertation on the hunting of seladang, but entirely apart from the great scientific interest attached to an animal such as this, it must be remembered that the fact of an animal carrying a desirable sporting trophy goes a long way toward insuring that it will not be ruthlessly exterminated. At least that applies in most countries, but not very strongly in Malaya where few white men now take any interest in the hunting of big game. The seladang is extraordinarily difficult to pick up in a dense jungle. It will, like all jungle animals, remain absolutely immobile directly it is suspicious that there is something abnormal in its vicinity, and in the dense jungle where it will be found (one's vision is confined to a circle of anything from 10 to 25 yards) it is almost impossible to see a dark animal like the seladang as long as it keeps still. Under such conditions the seladang's first move, which may or may not be preceded by a violent snort, is to swing around and disappear. I am presuming that the hunter is on the tracks of a solitary animal. A long stern chase of some hours will then take place and will probably be followed by an exactly similar circumstance. If the first approach to the seladang is unsuccessful, every subsequent approach will be more difficult. They are extraordinarily alert and until very old have good hearing and good eyesight. Their powers of smell are phenomenal, and the slightest taint in the wind will send them off at once. Hence to be a successful seladang hunter one has to be a persistent person, but the reward will come because some day either the hunter gets an unexpected piece of luck, or the seladang makes a mistake and awaits in a place where he thinks he is concealed but not sufficiently so to deceive the hunter. Or possibly the hunter's skill may exceed the seladang's caution, and the animal may be caught unawares.

I have followed seladang often for several days and they have given me a great deal of wonderful hunting. Despite the fact that a seladang is an enormously bulky animal, and an extremely active animal, except when very old, he seldom attacks a hunter even when wounded. Several times when following a wounded seladang I have been in such a position that he could almost certainly have made good a charge had he elected to be aggressive. But flight was more to his liking. Only once have I had a near call, and on that occasion the animal, badly wounded, pressed a charge. In fact he was so close to me that my shot hit him in the head at about 5 yards and the impetus of his rush carried the body past me.

But seladang hunting in the Malay Peninsula is nearly a thing of the past, because although they still exist in the country, their hunting is now highly commercialized, and seladang will not thrive where they are continually disturbed.

What of the future of the seladang? I wish I could give the answer. Although persistent efforts have been made during the last few years to

awaken a lethargic government to the importance of properly enforcing the game laws, and of taking proper steps to provide sanctuaries and refuges for the wild life of Malaya, nothing has been placed on a sound foundation, and it is extremely doubtful if it ever will be. Officials hate the idea of allowing a tract of country, that may contain minerals, timber or something else that will produce money, being tied up for the propagation of wild life, and it is difficult to impress office-holders with a realization of the value of wild life. In Malaya nearly the entire population consists of Malays, Chinese, or Indians. The Malays are the indigenous people, but they care nothing about the wonderful natural resources of the country. The others, including most of the Europeans, are here to get what they can out of the country, and without a realization of the necessity of a sound policy for the conservation of natural resources, wild life conservation in Malaya will fail. It is useless to state that in a few decades the natural resources of the country will be dissipated, because those who are sufficiently intelligent to understand, care nothing for the future beyond their own span of life. The Europeans in Malaya are birds of passage; the indigenous races cannot grasp the value of the wild life to their country. The only hope for the larger fauna of Malaya, seladang in particular, is to make inviolable sanctuaries, and unless we can get them, with no mining allowed, the larger wild life is doomed.

There are areas in Malaya that have been set aside and at the moment are ostensibly refuges for wild life, but it is a continual fight to procure money or personnel to guard these places, and, if the present apathy continues, it is only a matter of time when it will be considered not worth while. It is a deplorable thing to realize the fact, as I do from personal experience, that during the last 40 years in Malaya the larger forms of wild life have been so depleted that they are in grave danger of extermination, and so long as Malaya worships the cult of Mammon before everything else, it is difficult to see how matters can sufficiently improve to remedy the situation.

Pahang, Federated Malay States.

GEOGRAPHIC VARIATION IN THE MOLE SCAPANUS LATIMANUS

By Fletcher G. Palmer

INTRODUCTION

Moles of the genus *Scapanus* are confined to the Pacific coastal region from the Fraser River, British Columbia, south to the Sierra San Pedro Martir, Lower California, Mexico, and extend inland nowhere more than 300 miles from the ocean. In the area thus outlined are found 3 species of this genus, *townsendii*, *orarius*, and *latimanus*. Of these the last is the most widely ranging and shows greatest degree of geographic variation.

Scapanus latimanus is the one treated in the present paper, mainly from a systematic viewpoint. Wherever justifiable, however, inferences have been drawn as to correlation between subspeciation and geographic or other environmental factors.

MATERIALS AND ACKNOWLEDGMENTS

This review, in which 12 subspecies of *Scapanus latimanus* are recognized, is based on the study of 518 specimens, practically all of them study skins with skulls. Of these 12 races, 3 are described as new in the present paper. The types of 4 other subspecies have been examined, as also topotypes or near topotypes of all the others. One previously recognized subspecies is placed in synonymy.

Unless otherwise stated, specimens examined are in the Museum of Vertebrate Zoology. These have been supplemented by material in the private collections of Ralph Ellis, Henry S. Fitch, William B. Richardson, and Jack C. von Bloeker, Jr., all of Berkeley. To each of these I am greatly obliged for the privilege of examining their specimens; and also to the following individuals for the opportunity to study specimens in collections under their care; J. S. Dixon, of the National Park Service; Laurence M. Huey, of the San Diego Society of Natural History; the late H. S. Swarth, of the California Academy of Sciences; A. J. van Rossem, in charge of the D. R. Dickey collection; and George Willett, of the Los Angeles Museum. For counsel and suggestions during the progress of my study, I wish to thank Professors Joseph Grinnell and E. Raymond Hall of the Museum of Vertebrate Zoology.

DISTRIBUTION

The species *Scapanus latimanus* ranges from Fremont, Oregon, south through southern Oregon, California (excluding a narrow strip in the northwest humid coastal belt, the west side of the San Joaquin Valley, and the Colorado and Mohave deserts), and in Lower California, Mexico, in the higher portions through the Sierra Juarez and Sierra San Pedro Martir. Its

latitudinal range, then, is from about 43 degrees 30 minutes N. latitude south to about 31 degrees N. latitude. The eastern limits of the range of this species lie in extreme western Nevada from the Oregon boundary south to the East Walker River.

The interrelations and origin of the geographic races of this species can probably be more easily understood by a brief review of the barriers that it now encounters.

Limitation by life-zones.—Zonally, the species ranges from Lower Sonoran to Hudsonian, and the ranges of some of the subspecies are nearly as great. *Scapanus latimanus dilatus* ranges from the lower edge of Upper Sonoran to Hudsonian. In general the geographic distribution of the species appears to be independent of life-zones, although some of the races appear to be exceptional in this respect. For example, *campi* is restricted to the Lower and Upper Sonoran zones of the San Joaquin Valley and the west slope foothills of the Sierra Nevada. The Sierra Nevada above the range of *campi* is occupied by a closely related subspecies, *sericatus*.

Limitation by altitude.—Altitudinally the species, even the one subspecies *S. l. occultus*, ranges from near sea level to 9800 feet (as at Twin Lakes, Sequoia National Park, Tulare County, California). Probably the limitation by altitude results more from the effect of altitude on the other factors of the environment than from its effect on the moles themselves.

Limitation by humidity.—Probably the prime requisite for the existence of *Scapanus latimanus* in a given territory is ample soil moisture, dependent largely upon relative humidity and rainfall. This species, however, ranges much farther south and east than either *Scapanus townsendii* or *S. orarius*, which may not be as well adapted to semi-arid conditions. The ranges of the latter two species extend from the north into California only a short distance in the northwest humid coastal belt. The fact that *latimanus* ranges farther north in Oregon on the eastern, more arid, side of the Cascades than on the western, more humid side, may indicate that moisture in the soil is the limiting factor for this species. Probably the species has a certain range of soil-moisture which it can tolerate, and the margins of its geographic range in the northwestern coast and the southeastern desert may mark respectively the maximum and minimum of soil-moisture tolerated.

Moles cannot dig in dry, baked soils, but they may be found in the same type of soil if it have a higher moisture content. This was clearly seen by the writer in the case of the race *monoensis*. Along the East Walker River in Nevada, in July, 1934, surface ridges and deep burrows of this mole were common in the moist soil of the river banks. A few yards from the river, in the dry baked soil, there was no evidence of recent work by the moles. Evidence from old mounds and from conversation with residents of that vicinity indicated that moles in that locality extended their burrows into nearby fields when the soil had become sufficiently moistened by rains to

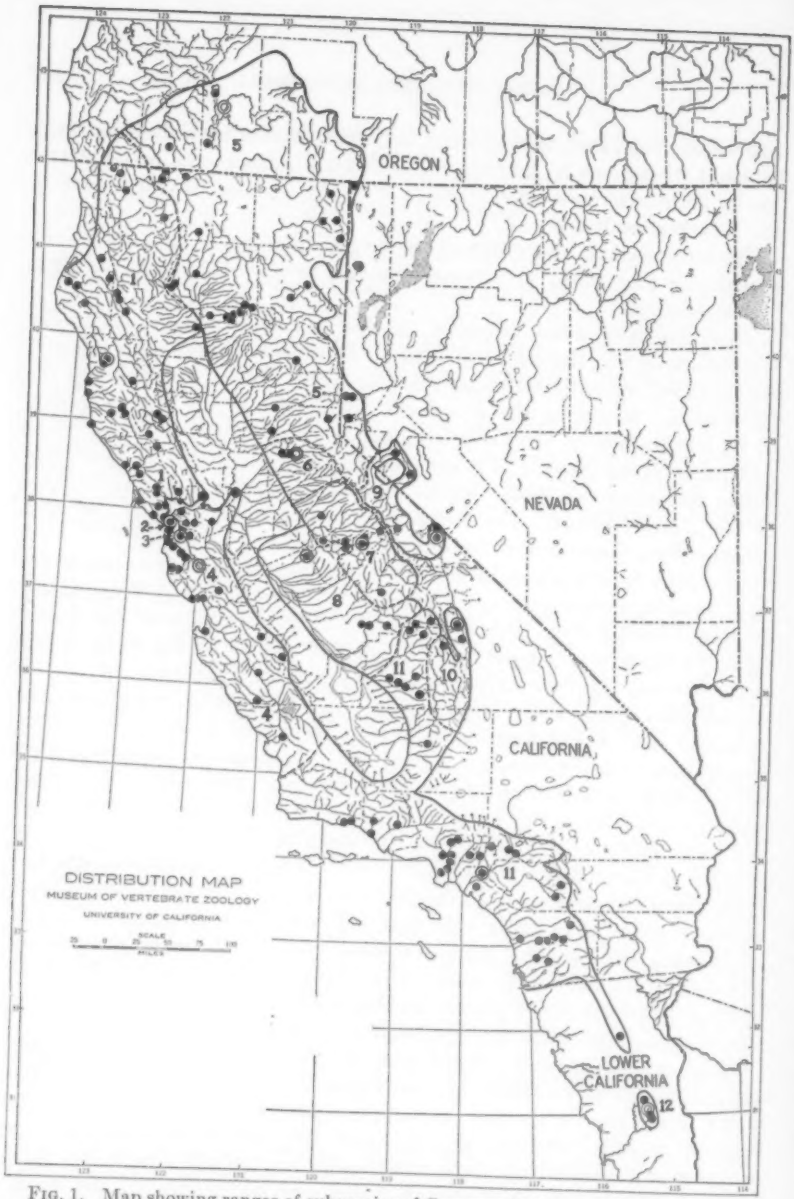

FIG. 1. Map showing ranges of subspecies of *Scapanus latimanus*. Broken lines indicate areas of intergradation. Solid circles indicate localities from which specimens were available for examination. Double circles indicate type localities. Double circles in which center circle is solid indicate type localities from which type specimen or topotypes were available for examination. 1. *caurinus*. 2. *insularis*. 3. *parvus*. 4. *latimanus*. 5. *dilatus*. 6. *minusculus*. 7. *sericatus*. 8. *campi*. 9. *monoensis*. 10. *grinnelli*. 11. *occultus*. 12. *anthonyi*.

allow them to dig there. Dry soils of a 'looser' type, in which moles can dig, probably are often uninhabited by moles because of the scarcity of invertebrate life suitable for food. The invertebrates that are present must be so adapted to high temperatures and aridity, by hard exoskeletons and other adaptations to prevent desiccation, that they are not of the type best suited for food. Also, the number of invertebrates in such situations is probably so low, as compared with their number in moister and cooler soils, that their bulk in the forage radius of an individual mole is below its minimum food requirements.

The existence of moles of such races as *dilatus*, *monoensis*, and *grinnelli* in desert regions is often dependent upon seepage from springs, rivers, and irrigation ditches. Populations of moles in Owens Valley and in west-central Nevada apparently depend for soil moisture to a large extent on the flow of rivers and smaller streams eastward from the Sierra Nevada. The Mohave and Colorado deserts and the west side of the San Joaquin Valley are, as far as known, uninhabited by moles. It is probable that lack of moisture in those regions accounts for the absence of moles there.

Limitation by temperature.—Temperature probably has but little direct effect upon the presence or absence of moles in a given area. Since these animals spend the greater part of their lives underground, they are protected most of the time by an insulating layer of earth that maintains a more constant temperature in the burrows than that of the air at the ground surface. Freezing of the ground to any great depth, would, no doubt, be more important as a limiting factor than high temperatures, because it would make digging impossible and probably would greatly reduce the available food supply.

Indirect effects of temperature on these moles, through its influence on other factors of the environment, are probably of much greater importance than any direct effects on the moles themselves. Effects of temperature on relative humidity and rainfall must definitely limit the areas that can be occupied by this species, and probably also must play a definite part in its subspeciation.

Limitation by edaphic factors.—It is doubtful that edaphic factors are of much importance in determining the distribution and subspeciation of *Scapanus latimanus* over most of its range, but these factors may be important in certain areas. Although moles are extremely specialized for digging, they cannot cope with rocks or very coarse gravel. Very rocky or gravelly soil is rarely occupied, and the maximum population will be found in the fine-textured, deep soils if other factors of the environment are equal. This can probably be correlated to some extent with the scarcity of food in the porous, rocky type—it being poorly adapted for invertebrate life. Three of the specimens known to have been found on or in gravelly or rocky soils are young of the year. Were they pushing out into new territory in response

to post-breeding season population pressure? It seems doubtful to the writer that existence can be maintained in such situations during the more critical periods of the year.

Extremely rocky ground, bare rocky mountain slopes, and rocky gorges may be barriers to distribution of this species. Such barriers function most importantly in the Sierra Nevada of California. For example, *sericatus* of the Yosemite region and *grinnelli* of the Owens Valley are separated by the high, rocky peaks of the Sierra. Grinnell, Dixon, and Linsdale (1930, p. 449) have pointed out that in the Lassen section of northern California, ". . . if intergradation takes place within our section between the races *latimanus* and *dilatus*, it must occur within the narrow width of territory, certainly less than ten miles, between the eastern edge of the Sacramento River bottom and Dale's on Paine's Creek. But Paine's Creek below Dale's flows through a narrow, rock-walled gorge, where conditions look unfavorable to the existence of any moles. So there may be an actual no-man's land at this latitude between the ranges of *latimanus* and *dilatus*".

Limitation by water barriers.—The most obvious barrier to distribution of moles to the westward is the Pacific Ocean. No moles are known from any of the channel islands off the coast of southern California. Migration of the basic stock of this species from the northward may not have reached southern California as early as the time when the insular area was segregated from the mainland. Or, if these moles did reach the insular region, adverse environmental conditions there probably effected their disappearance.

The second most important water barrier influencing the distribution of this species comprises San Francisco Bay, Suisun Bay, and the lower Sacramento River. This body of water has been instrumental in the evolution of 4 distinct subspecies. It is probable that the basic stock of these 4 races was divided into 2 parts by the Sacramento River and the formation of San Francisco Bay. The part north of this body of water developed into *caurinus*. At that time, the San Francisco Peninsula probably extended north to include what is now Angel Island, the Sacramento River then draining through Raccoon Straits and the Golden Gate (Lawson, 1894, p. 266). Later, when the connection between the present San Francisco Peninsula and Angel Island had subsided, a portion of the possible mole population would have been isolated. Or the moles may have been transported to the island after it had become separated from the mainland. At any rate, that population, through isolation by water barriers, has developed into the subspecies *insularis*. Although Alameda is separated from the mainland only by a rather narrow tidal estuary, this seems to be an effective barrier to the moles. At any rate those on the island (*parvus*) are distinctly different from those on the mainland. It is also possible that the Alameda estuary is not an impassable barrier, but that *parvus* is a salt marsh form occupying a narrow strip around the southern and eastern margins of San Francisco Bay. If that be

true, it probably developed along with salt-marsh species or subspecies of other mammals in that area, such as *Reithrodontomys raviventris*, *Sorex vagrans halicoetes*, and *Microtus californicus paludicola*, all distinct from closely related upland forms.

No other bodies of water are thought to have markedly affected the distribution and subspeciation of these moles. Their habit of living along moist river banks and stream-sides probably often allows moles to be transported from one side of a stream to the other in rafts of root-bound soil, or by swimming. Many rivers in California flow only intermittently, and not at all in the dry season. At such times, moles can cross the stream bed on mud or sand bars. One was collected on a small island in the East Walker River, Nevada, when, at high water stage that stream was in process of shifting its main channel, and another specimen was captured while it was swimming in the Merced River in Yosemite National Park. Clearly a mixing of populations from opposite sides of many rivers within the range of *Scapanus latimanus* is possible.

VARIATION

Geographic variation.—Throughout the species *Scapanus latimanus*, there are, in addition to subspecific characters, certain tendencies manifested in response to broad environmental factors. This species conforms nicely with Bergmann's Law, showing, in general, a gradual decrease in size from north to south, and also from west to east. Size probably is correlated to some extent with the factor of humidity; moles from the more humid parts of the range of the species are generally larger, the extreme in large size of body and skull being reached in *caurinus* in Humboldt County, California. There is a gradual decrease in size down the coast, along with a decrease in humidity, through *insularis*, *latimanus*, and *occultus*, reaching the extreme in the southernmost race, *anthonyi*, of the Sierra San Pedro Martir, Lower California, Mexico. From the coast toward the more arid interior there also is a decrease in size, at the north from *caurinus* to *dilatus*, and at the south from *latimanus* to *minusculus*, *campi*, and *sericatus*, which likewise are successively smaller than *dilatus*. Eastward from these subspecies are still smaller ones, *monoensis* and *grinnelli*, that occupy territory at the margins of the desert. The one subspecies that fails to conform to this rule is *parvus*. This race, known only from Alameda Island, in San Francisco Bay, is about the same in size as *grinnelli* or *occultus*, subspecies occurring much farther south and inland, and is much smaller than *latimanus*, its near neighbor on the mainland.

The correlation of color with climatic factors is readily observable. From north to south there is a tendency for paling of coloration correlated, no doubt, with decrease in wetness of climate, and from humid coast to semi-arid inland, the same correlation obtains. This has been shown also, by

Grinnell (1921, p. 14), for the kangaroo rats of California, and has been observed in many other kinds of mammals and in birds. The races occupying semi-arid regions, *dilatus*, *monoensis*, *campi*, and *occultus*, are paler. The Sierran races, *minusculus* and *sericatus*, are definitely much darker than adjoining races in lower life zones, apparently because of the higher humidity of the mountainous area. One subspecies that does not conform to this generalization is *grinnelli*. Although it occupies a part of the rather arid Owens Valley, it is one of the two or three darkest subspecies of *Scapanus latimanus*. This may mean that the known specimens represent a marginal, and zonally low population of a race whose range is principally in the southern Sierra Nevada; or, the subspecies developed in the Sierra, and its migration into the Owens Valley is comparatively recent; or, environmental conditions in the Owens Valley have changed very rapidly from humid to arid and the characters of the mole have not yet had time to change in response to those new conditions. To me, the last explanation is the most plausible. Also, I think of this population of moles in the Owens Valley as a relic of a form, formerly ranging more widely, along the shores and marginal areas of the once much larger Owens Lake. Structural features showing marked degrees of geographic variation are discussed in the accounts of the various races.

Individual variation.—The size and shape of skulls in animals of the same sex and age from one locality are relatively constant. Among the variations noted, one of the most frequently occurring is difference in shape of the posterior border of the palate. As Jackson (1915, p. 17) has pointed out, it is commonly true in individuals of a series that this border may be straight or notched. Another common variation is in the number of teeth; at least 10 per cent of the specimens examined have abnormal dentitions. The tendency usually is toward reduction in number but in a few specimens examined there has been an increase in number of teeth. The increase or reduction in every specimen involved the premolars. The subspecies most commonly subject to abnormalities of the teeth, at least in the specimens examined, are in increasing order, *latimanus*, *occultus*, and *anthonyi*, the tendency culminating in the latter. Crowding of the teeth is probably the direct cause of the reduction, especially in races having smaller skulls.

Abnormalities in color are less common, the general color for a series of adults from a given locality being fairly constant except for variation depending on molt or wear. Even so, a few individuals are partially 'albinistic' with spots of cream or whitish, usually on the face or chin. Still fewer specimens show spots of orange on the chin or chest region. One skin (of *occultus* from San Gabriel, Los Angeles County, no. 6928 Calif. Acad. Sci.) is Pale Yellow Orange all over with no trace of darker color. Another specimen from the same locality has been recorded by Miller (1921, p. 164) as of a "light cinnamon yellow" color.

Age variation.—There is little change with increasing maturity in mole

skulls after the animals are old enough to fend for themselves, and hence to be trapped. The most noticeable alterations comprise a flattening and a slight broadening of the braincase, and a slight increase in maxillary breadth due to thickening of the sub-lacrimal maxillary ridges. In subadult specimens, the external roots of the molariform teeth are often exposed through the maxillae. Development of a sagittal crest on the skull is a sign of old age. Relative amount of wear of molar teeth was used in this study as the primary criterion for comparative age determination. Because of differences in types of soil inhabited, moles of the same age but from different localities may exhibit slightly different degrees of wear of the molariform teeth, but this is probably not great. There apparently is no color change in adults with old age, but immature specimens are grayer than adults.

Secondary sexual variation.—The only difference of this nature encountered is the slightly larger size of males, especially noticeable in the skulls. The difference is least in the larger subspecies of the humid coastal belt, and most in the smaller subspecies of more arid regions.

Seasonal variation.—The only marked seasonal variation noted was in color of pelage. Winter pelages are uniformly darker than summer pelages. In the semi-arid regions this change is more marked than in humid localities. Apparently color easily fades, especially under the influence of a dry climate, and specimens in worn and faded pelage often look very different from those in fresh pelage from the same locality. Time and method of molting in the genus *Scapanus* has been fully discussed by Jackson (1915, pp. 11–15) and need not be considered here.

METHODS AND MEASUREMENTS

External measurements are given in millimeters and are those taken by the collector from the mole in the flesh. The following measurements have been used in this study:

Total length.—Length of body and tail from tip of nose to tip of tail vertebrae. *Tail vertebrae.*—Length of tail, taken with tail bent at a right angle to the back from a point on upper side at base, to tip of fleshy part of tail. *Hind foot.*—Length of hind foot from heel to tip of longest claw.

Cranial measurements have all been made by the author with vernier calipers reading to tenths of a millimeter. All averages and ratios of percentages have also been determined by the author, the latter usually by slide-rule calculation. Cranial measurements are principally those used by Jackson (1915, p. 19). Measurements so taken by the writer do not always agree with those given by Jackson for the same specimens. This discrepancy probably is due to differences in measuring instruments or possibly to differences in technique. Certain measurements have been added to those used by Jackson and have been useful in showing differences between closely similar subspecies. The following cranial measurements have been employed in this study:

Greatest length.—Length of the skull from anterior median point between bases of first upper incisors to most posterior point of supraoccipital in median line. *Palatal length.*—Length of the palate from anterior median point between bases of first upper incisors to posterior median border of the palate; more useful in this particular study than *palatilar length* used by Jackson. *Mastoidal breadth.*—Greatest breadth of the skull taken through the mastoids. *Interorbital breadth.*—Breadth of the interorbital region, at a line marking the cribriform plate that can be seen through the roof of the skull (essentially the same as the coronal suture used by Jackson). *Maxillary breadth.*—Breadth of the skull measured just in front of the anterior bases of the zygomatic arches immediately above second upper molars. *Rostral breadth.*—Breadth of the rostrum at the canines. *Depth of skull.*—Depth of the braincase at deepest point of bullae, taken at a right angle to a plane surface on which skull is resting (a glass microscope slide of known thickness gives best results). *Length of orbit.*—Greatest antero-posterior inside length of orbit from the angle formed by the bar lateral to infraorbital foramen and frontal region to postero-lateral angle of zygomatic arch. Taken with inside measuring calipers. *Maxillary tooth-row.*—Antero-posterior length of upper molar-premolar row measured at alveolar border, P^1 to M^3 inclusive. *Mandibular molar-premolar row.*—Antero-posterior length of lower molar-premolar row measured at alveolar border.

DETERMINATION AND COMPARISONS OF COLOR

All capitalized color terms refer to Ridgway, "Color Standards and Color Nomenclature", 1912. Color terms otherwise designated are general terms used to indicate general tone or mass effect.

There are many difficulties in matching colors of moles because of iridescence and reflection from the pelage, causing individual specimens to vary in color when viewed from different angles. To secure uniform results, comparisons were made following the method used by Jackson (1915, p. 20): "Diffused daylight from a window was allowed to strike the animal at an angle of 30° to 45° posterior to a plane perpendicular to the median longitudinal line of the animal. The mole was then viewed from the anterior end at an angle of about 60° from the light rays and in the same plane with them."

Wherever possible, fresh pelages of both summer and winter have been described. Lack of material for some subspecies, however, has made it necessary to describe the color only of worn pelage, which is markedly different from that of the fresh coat. It is also often difficult to determine, especially in the spring, in just what pelage a specimen may be. Probably the best method for determining the pelage is to examine the specimen for abrasion of the hair; unabraded hairs indicate fresh pelage and abraded hairs old and worn pelage, the old and new pelages often being separated by a distinct molt line.

ARTIFICIAL KEY TO THE SUBSPECIES OF SCAPANUS LATIMANUS

1. Size large, total length averaging more than 165 mm. Greatest length of skull more than 34.5 mm. in ♂♂ and 34.4 in ♀♀.
   2. Greatest length of skull averaging more than 36.3 mm. in ♂♂ and 35.6 mm. in ♀♀. Ratio of mastoidal breadth to greatest length of skull averaging less than 48% for ♂♂ and 47.6% for ♀♀. Coastal region north of San Francisco Bay..*caurinus*
   2′. Greatest length of skull averaging less than 36.3 mm. in ♂♂ and 35.6 mm. in ♀♀. Ratio of mastoidal breadth to greatest length of skull averaging more than 48% for ♂♂ and 47.6% for ♀♀.
      3. Mastoidal breadth more than 50.2% and interorbital breadth more than 23% of greatest length of skull. Size larger, hind foot averaging more than 23 mm. Angel Island, San Francisco Bay.....*insularis*
      3′. Mastoidal breadth less than 50% and interorbital breadth less than 23% of greatest length of skull. Size smaller, hind foot averaging less than 23 mm.
         4. Color dark, Fuscous to Fuscous Black in fresh winter pelage.
            5. Greatest length of skull averaging less than 34.3 mm. Rostrum shorter. Palate short, less than 43.4% of greatest length of skull. Placerville region of the Sierra Nevada.....*minusculus*
            5′. Greatest length of skull averaging more than 34.3 mm. Rostrum longer. Palate long, more than 44% of greatest length of skull. Coastal region from San Francisco Bay south to San Luis Obispo Co.....*latimanus*
         4′. Color pale and grayish, never as dark as Fuscous in fresh winter pelage. Southern Oregon, northeastern Calif., and west-central Nev.....*dilatus*
1′. Size smaller, total length averaging less than 165 mm. Greatest length of skull less than 34.5 mm. in ♂♂ and 34.4 in ♀♀.
   6. Total length more than 161 mm. Greatest length of skull more than 34.0 mm. in ♂♂ and 33.4 mm. in ♀♀. Ratio of mastoidal breadth to greatest length of skull less than 49%.
      7. Color darker, more grayish. Ratio of maxillary breadth to greatest length of skull less than 29%. Sierra Nevada from Yosemite south to Shaver Ranger Station .....*sericatus*
      7′. Color paler, more brownish. Ratio maxillary breadth to greatest length of skull more than 30%. San Joaquin Valley, Merced Co., south to northwestern Tulare Co.....*campi*
   6′. Total length less than 161 mm. Greatest length of skull less than 34.0 mm. in ♂♂ and 33.4 in ♀♀. Ratio of mastoidal breadth to greatest length of skull more than 49%.
      8. Mastoidal breadth more than 50%, interorbital breadth more than 23.1%, and rostral breadth more than 13.2% of greatest length of skull.
         9. Palate short, ratio palatal length to greatest length of skull less than 44%. Rostral breadth equalling more than 13.6% of greatest length of skull but rostrum long. Braincase inflated, depth at bullae more than 29% of greatest length of skull. Alameda, Alameda Co.....*parvus*
         9′. Palate longer, palatal length more than 44% of greatest length of skull. Rostral breadth equalling 13.6% or less of greatest length of skull; rostrum short. Braincase flattened, ratio depth at bullae to greatest length of skull less than 29%.
            10. Greatest length of skull more than 32.0 mm. Total length greater than 155 mm. Skull deep, average depth of skull at bullae more than 28.5% of greatest length of skull. Southern part of Owens Valley....*grinnelli*
            10′. Greatest length of skull less than 32.0 mm. Total length less than 155 mm.

Skull shallow, average depth of skull at bullae less than 28.5% of greatest length of skull. Sierra San Pedro Martir, Lower Calif., Mexico ..... *anthonyi*

8′. Skull moderately broad. Mastoidal breadth typically less than 50%, interorbital breadth less than 23.1%, rostral breadth less than 12.9% of greatest length of skull.

11. Size larger, hind foot averaging more than 20 mm. Color paler, more grayish. Greatest length of skull more than 33 mm. in ♂♂ and 32.8 mm. in ♀♀. Interorbital constriction slight. Mono Lake region of Calif. and along East Walker and West Walker rivers, Nev. ..... *monoensis*

11′. Size smaller, hind foot averaging less than 20 mm. Color darker, more brownish. Greatest length of skull less than 33 mm. in typical ♂♂ and 32.8 in typical ♀♀. Interorbital constriction well marked. Sierra Nevada south of Kings River, southern Calif., and Sierra Juarez, Lower Calif., Mexico ..... *occultus*

Scapanus latimanus caurinus new subsp.

Type.—Adult, male, skin and skull; no. 25,388, Mus. Vert. Zool.; Laytonville, Mendocino County, California; collected by Frank Clarke, May 14, 1917; prepared by H. S. Swarth, orig. no. 10,590.

Range.—Coastal region of California north of San Francisco Bay, except narrow strip north to Oregon line from Humboldt Bay, and west of the Sacramento Valley except at its extreme northern end. Altitudinal range from near sea level (Bolinas, Marin County) to 5500 feet (South Fork Mountain, Humboldt County). Zonal range, Upper Sonoran through Canadian.

Diagnosis.—Size: Largest of the species (see measurements). Color: Dark, averaging near Fuscous Black in fresh winter pelage, slightly lighter in summer pelage. Skull: Long, and relatively narrow throughout; rostral breadth only 13 per cent or less of greatest length in males, and 12.9 per cent or less in females; zygomata tending to be straight; maxillary breadth averaging 27.9 per cent of greatest length in males; mastoidal breadth averaging less than 48 per cent of greatest length in males, and 47.6 per cent in females.

Color.—In fresh winter pelage, Chaetura Black to Fuscous Black above; lighter below. In summer pelage, generally Fuscous or Mummy Brown above, Chaetura Drab to Light Grayish Olive below.

Comparisons.—In comparison with *latimanus*, *caurinus* averages much larger, being approached in size only by specimens of *latimanus* from Santa Cruz, Santa Cruz County. The ratio of width measurements to greatest length of skull averages less for all measurements in *caurinus* except that of the interorbital breadth, which is about the same for both subspecies. Also the rostrum is both relatively and actually longer in *caurinus*, and the zygomata are more nearly straight (less bowed out). For further comparison see Table I and key. For comparison with *dilatus* see *Comparisons* for that race.

Remarks.—San Francisco Bay has been an effective barrier for moles, as for many other kinds of vertebrates. Although unable satisfactorily to distinguish moles on opposite sides of the Bay, with the material he had, Jackson (1915, p. 67) noted that, ". . . specimens from the coast region north of San Francisco Bay seem to average slightly larger and darker than typical specimens, . . ." From the more adequate material used in the present study, however, it is evident that there are characters in addition to those noted by Jackson by which *caurinus* may be distinguished.

Specimens from most localities within the range of *caurinus* agree with the series from the type locality and differ from *latimanus* in size and proportions of the skull. Specimens from Marin County and southern Sonoma County, however, are narrower interor-

bitally and have more widely spreading zygomata. In this they resemble *latimanus*, but in all other differential characters they agree with the type series.

Seven males from the South Fork Mountain region in Humboldt and Trinity counties have greater rostral breadth than topotypical *caurinus*. This may be correlated with age, since all are very old as shown by extreme tooth wear and ridging on the skull. They agree with topotypes in all other characters.

Specimens from Red Bluff, Tehama County, the easternmost record station for this subspecies, are typical of the race and in structural characters show no approach toward the eastern race *dilatus*. Intergradation with *dilatus* takes place over a broad area in southern Oregon and northern California; intermediates (referred to *dilatus*) are available from Hornbrook on the Klamath River and from the head of Doggett Creek and Donomore Meadow in the Siskiyou Mountains. These specimens from the eastern end of the mountain range approach *dilatus* in smaller size of skull, relatively greater mastoidal and interorbital breadth, and paler (more grayish) color. Those from the western end, as at Poker Flat, are more brownish in color and have narrower skulls, indicating closer affinities with *caurinus*. Specimens referred to *dilatus* from 6 miles south of Medford, Oregon, are typical of *dilatus* in skull characters but are typical of *caurinus* in color, which is much darker than in specimens from the Siskiyou Mountain region to the south. Specimens (formerly known as *alpinus*) from Crater Lake, Oregon, are apparently intergrades between *caurinus* and *dilatus*. (See under the account of *S. l. dilatus*.)

One specimen from Scott River, Siskiyou County, has skull characters much like those of animals from the Siskiyou Mountains. It more nearly approaches *caurinus* in proportions of the skull, however, and is referred to that race. The only tendencies toward *dilatus* are in the small size and paler color. Jackson, who examined this specimen in course of preparation of his paper (1915), marked it "*latimanus*, not typical."

Specimens examined.- Total number 94, all from California: *Del Norte Co.:* E. Fork Illinois River, 1900 ft., 0.25 mi. S. Oregon line, 1. *Siskiyou Co.:* Klamath River, 1000 ft., mouth of Clear Creek, 1; Poker Flat, 5800 ft., 12 mi. N. W. Happy Camp, 2; Scott River, 6 mi. N. W. Callahan, 1. *Humboldt Co.:* Horse Mountain, 4700–5000 ft., 2; South Fork Mountain, Blake Lookout, 1; 1 mi. S. E. Fernbridge, S. side Eel River, 1; Carlotta, 14 (11, Dickey Coll.); Cuddeback, 2; Dyerville, 1 (Dickey). *Trinity Co.:* The Racetrack, South Fork Mountain, 2; Reilly's Ranch, South Fork Mountain, 1; Mad River Ford, above Ruth, 1; Horse Ridge, S. E. Ruth, 5500 ft., 1. *Tehama Co.:* Red Bluff, 6 (3 Dickey). *Mendocino Co.:* Laytonville (and 6 mi. S. W.), 21; Fort Bragg, 3; Mendocino City, 1; Mt. Sanhedrin, 4500 ft., 1; Philo, 1; Ukiah, 2 mi. W., 1; Ukiah, 5 mi. S., 1; Point Arena, 1. *Lake Co.:* 3 mi. S. Bartlett Springs, 1; Long Valley, 1; Harbin Springs, 1 (Calif. Acad. Sci.); Glenbrook, 1 (Calif. Acad. Sci.). *Sonoma Co.:* Guerneville, 4; Freestone, 3; 7 mi. W. Cazadero, 1; 1 mi. N. W. Petaluma, 2; 1.5 mi. S. W. Petaluma, 2. *Marin Co.:* Bolinas, 1; 3 mi. N. Fairfax, 1; Mill Valley, 1; Ignacio, 1; 2 mi. N. E. San Rafael, 1; Inverness, 2 (San Diego Soc. Nat. Hist.); Paradise Cove, S. F. Bay, 1. *Napa Co.:* 2 mi. S. W. Napa, 1; 3 mi. S. Napa, 1. *Solano Co.:* Lake Chabot, 1.

Scapanus latimanus dilatus True

Scapanus Townsendii, Townsend, Proc. U. S. Nat. Mus., vol. 10, p. 182, 1887 (part).

Scapanus dilatus True, Proc. U. S. Nat. Mus., vol. 17, p. 242, 1894 (orig. desc.).

Scapanus truei Merriam, Proc. Biol. Soc. Washington, vol. 11, pp. 101–102, 1897 (type loc., Lake City, Modoc County).

Scapanus alpinus Merriam, Proc. Biol. Soc. Washington, vol. 11, p. 102, 1897 (type loc. Crater Lake, Klamath County, Oregon; altitude about 7000 feet).

Scapanus truii [*sic*], Elliot, Field Columbian Mus., Zool. ser., vol. 6, p. 469, 1905.

Scapanus californicus truei, Stephens, California Mammals, San Diego, p. 259, 1906.

Scapanus latimanus truei, Grinnell, Proc. California Acad. Sci., vol. 3, p. 270, 1913.
Scapanus latimanus dilatus, Jackson, North Amer. Fauna, no. 38, pp. 72–74, 1915.
Scapanus latimanus alpinus, Jackson, North Amer. Fauna, no. 38, p. 75, 1915.

Type.—Adult, sex unknown, skeleton; no. 186,628, U. S. Nat. Mus., Merriam collection; Fort Klamath, [4200 ft.], Klamath County, Oregon; some time during 1883; collected by Charles E. Bendire (*fide* True, 1894, p. 242).

Range.—South-central Oregon, northeastern California east from eastern end of Siskiyou Mountains and western base of Sierra Nevada, and extreme western edge of Nevada, south at least to 39 degrees N. latitude. Altitudinal range from 600 feet (at Dale's on Paine's Creek, Tehama County) to 8500 feet (at Lake Helen, Shasta County). Zonal range, Upper Sonoran to Hudsonian.

Diagnosis.—Size: Large. Color: Palest of all the subspecies of the *latimanus* group, generally with silvery gray cast. Skull: Large with anterior part of the skull narrow and rostrum long; palate long; interorbital region narrow; orbits short and narrow; braincase long and broad, narrow posteriorly with pronounced supraoccipital ridge.

Color.—In fresh winter pelage, between Chaetura Drab and Deep Mouse Gray above; Drab to Mouse Gray below. In worn winter pelage, Light Drab to between Hair Brown and Benzo Brown above; Drab, Mouse Gray, or Deep Mouse Gray below. In fresh summer pelage, average between Hair Brown and Benzo Brown above; Light Grayish Olive, Mouse Gray, or Deep Mouse Gray below. In worn summer pelage, generally near Drab or Hair Brown above; Drab to Mouse Gray below, usually stained with tawny on chin, chest, and midventral line.

Comparisons.—Compared with *caurinus*, the skull is, in actual measurement, shorter, with rostrum relatively shorter but about equal in width; interorbital region narrower; maxillary breadth relatively greater with sublacrimal-maxillary ridges heavier; orbits shorter and wider; mastoidal breadth relatively greater (see Table 1). In color, *dilatus* is lighter and tends to be silvery gray. Light colored or faded specimens of *caurinus* have a light brownish cast rather than grayish. From *latimanus*, *dilatus* differs: In lighter color, narrower skull anterior to the median part of the brain case; shorter as well as narrower orbits; in higher extension of foramen magnum and more pronounced supraoccipital ridge. Compared with *monoensis*, *dilatus* is larger, but of similar color; the skull is longer and narrower, and differs in other characters as given under *Comparisons* in the account of *monoensis*. Specimens of *dilatus* can be distinguished from *minusculus* by characters as given under *Comparisons* in the account of *minusculus*.

Remarks.—This subspecies exhibits great variation between local populations and shows fewer constant characters than most of the other subspecies. Study of additional material may warrant according subspecific status to some of these variant populations.

There are at hand no topotypes of *dilatus* and the type is not available for the present study. Jackson (1915, pls. 4, 5, 6), however, gave photographs of the skull of the type and (*op. cit.*, p. 73) several measurements of it. Few of the specimens examined equal the extreme relative width of the type. From within the range of typical *dilatus*, material nearest to the type locality is the specimen from the south end Lake of the Woods, 5025 feet, Klamath County, Oregon, which is about 26 miles southeast from, and 1000 feet higher than, the type locality. This specimen (no. 54,896, Mus. Vert. Zool.) has a skull of nearly the same relative proportions as the type, but is of greater actual dimensions, as judged by Jackson's (1915) account of the type.

Jackson attributed the narrow rostrum of the type of *truei*, named from northeastern California, in part to its immaturity. It appears from this study, however, that even in adults of *dilatus* from this general region, the ratio of average width of rostrum to greatest length of skull is less than in *latimanus*, being only slightly greater in this respect than in *caurinus*.

TABLE 1

RATIOS OF AVERAGE CRANIAL MEASUREMENTS TO AVERAGE GREATEST LENGTH OF SKULL, EXPRESSED IN PER CENT

	Caurinus ♂ 10 (TYPE & TOPOTYPES)	*Caurinus* ♀ 8 (TOPOTYPES)	*Insularis* ♂ 2 (TYPE & TOPOTYPE)	*Insularis* ♀ 1 (TOPOTYPE)	*Latimanus* ♂ 9 (MENLO PARK, SAN MATEO CO. & PALO ALTO, SANTA CLARA CO., CALIF.)	*Latimanus* ♀ 4 (MENLO PARK & LA HONDA, SAN MATEO CO., CALIF.)	*Parvus* ♂ 1 (TYPE)	*Parvus* ♀ 1 (TOPOTYPE)	*Dilatus* ♂ 2 (LASSEN PEAK REGION OF NORTHERN CALIF.)	*Dilatus* ♀ 3 (LASSEN PEAK REGION OF NORTHERN CALIF.)	*Minusculus* ♂ 1 (4 MI. E. OF PLACERVILLE, ELDORADO CO., CALIF.)	*Minusculus* ♀ 1 (PLACERVILLE)	*Sericatus* ♂ 11 (TOPOTYPES)	*Sericatus* ♀ 7 (TOPOTYPES)	*Campi* ♂ 4 (MINKLER, FRESNO CO., CALIF.)	*Campi* ♀ 4 (MINKLER, FRESNO CO., CALIF.)	*Monoensis* ♂ 6 (TOPOTYPES)	*Monoensis* ♀ 6 (TYPE & TOPOTYPES)	*Grinnelli* ♂ 2 (TYPE & TOPOTYPES)	*Grinnelli* ♀ 5 (TOPOTYPES)	*Occultus* ♂ 7 (LOS ANGELES & VICINITY, LOS ANGELES CO., CALIF.)	*Occultus* ♂ 6 (PASADENA & COVINA, LOS ANGELES CO., CALIF.)	*Anthonyi* ♂ 1 (LA GRULLA, SIERRA SAN PEDRO MARTIR, LOWER CALIF., MEXICO)	*Anthonyi* ♀ 1 (LA ENCANTADA, SIERRA SAN PEDRO MARTIR, LOWER CALIF., MEXICO)
Greatest length	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Palatal length	43.6	43.8	44.7	44.7	44.1	44.4	42.4	43.4	43.7	43.6	43.3	44.4	43.7	44.2	44.9	44.9	43.7	44.5	45.1	44.6	43.8	43.0	44.9	44.3
Mastoidal breadth	47.3	47.4	50.2	50.3	48.6	48.7	51.2	50.0	48.4	48.2	50.6	48.6	48.4	48.4	48.4[1]	48.7	49.7	49.4	50.9	50.8	49.1	50.0	50.8	51.5
Interorbital breadth	22.3	22.4	23.0	23.4	22.2	22.8	23.2	23.2	22.1	22.1	22.9	22.3	22.0	22.2	22.9[1]	23.3	23.3	23.1	22.9	23.8	24.0	22.7	23.0	23.2	23.0
Maxillary breadth	27.8	27.9	29.1	29.1	29.0	28.8	29.9	29.3	28.1	27.8	29.4	27.9	28.4	28.5	30.4	30.2	29.3	29.5	30.1	30.4	29.2	29.0	30.1	29.8
Rostral breadth	12.7	12.6	13.5	13.4	13.1	13.1	14.0	14.0	12.3	12.3	14.1	13.2	12.3	12.7	13.3	13.2	12.6	12.5	13.3	13.2	12.8	12.9	13.6	12.2
Depth of skull	28.9	28.7	28.3	29.3	29.0	29.2	30.5	30.5	29.0	29.0	30.6	28.5	29.6	28.8	28.1[1]	28.4	29.5	28.3	28.9	28.9	29.2	29.3	27.8	28.9
Length of orbit	26.1	26.3	27.0	25.4	26.4	26.2	26.8	27.1	24.1	24.3	25.9	25.6	26.4	25.8	26.1	26.0	26.0	26.2	25.9	25.5	25.8	25.5	27.2	27.4
Maxillary tooth-row	31.3	31.4	30.9	31.6	31.0	31.5	30.5	31.1	32.2	31.6	31.8		31.7	31.7	31.9	31.7	31.4	31.9	31.6	32.0	31.8	31.2	30.7	28.8
Mandibular molar-premolar row	30.0	29.6	29.8	30.4	29.8	30.3	28.3	28.6	30.5	30.7	30.6	39.4	30.5	30.8	30.7	31.1	29.9	30.5	30.1	30.4	30.1	29.8	29.4	29.6

[1] Measurements for only 3 specimens.

TABLE 2

AVERAGE AND EXTREME MEASUREMENTS, IN MILLIMETERS, OF ADULTS AND SUBADULTS OF TWELVE RACES OF SCAPANUS LATIMANUS

RACE	NO. OF SPECIMENS	TOTAL LENGTH	TAIL VERTEBRAE	HIND FOOT	GREATEST LENGTH OF SKULL	PALATAL LENGTH	MASTOIDAL BREADTH	INTERORBITAL BREADTH	MAXILLARY BREADTH	ROSTRAL BREADTH	DEPTH OF SKULL	LENGTH OF ORBIT	MAXILLARY TOOTH-ROW	MANDIBULAR MOLARPREMOLAR ROW
caurinus (Laytonville)	10 ♂	180.2	35.4	22	36.4	15.9	17.2	8.1	10.1	4.6	10.5	9.5	11.4	10.9
		164–190	32–38	21–23	35.5–37.4	15.6–16.4	16.7–17.8	7.9–8.6	9.8–10.3	4.4–4.8	10.2–10.7	9.2–9.8	11.2–11.6	10.6–11.3
insularis		180	37	23.3	37.0	16.6	18.6	8.5	10.8	5.0	10.5	10.0	11.5	11.0
	2 ♂	177–183	36–38	23.0–23.5	36.9–37.1	16.5–16.6	18.5–18.6	8.5–8.5	10.7–10.8	5.0–5.0	10.3–10.6	10.0–10.0	11.4–11.5	11.0–11.0
latimanus (nr. Palo Alto)		171.7[2]	34.7[2]	21.3[2]	35.2	15.5	17.1	7.8	10.2	4.6	10.2	9.3	10.9	10.5
	9 ♂	170–175	29–40	20–22	34.1–35.8	14.8–15.9	16.5–17.9	7.6–8.1	9.8–10.4	4.3–4.9	9.5–10.8	8.8–9.7	10.7–11.0	10.3–10.7
parvus (type)	1 ♂	160	33	18 (s. u.)	32.8	13.9	16.8	7.6	9.8	4.6	10.0	8.8	10.0	9.3
dilatus (Eagle Lake)		173.2	36	22	35.0	15.1	17.0	8.1	9.9	4.6	9.9	8.8	10.9	10.6
	4 ♂	160–185	34–40	21–25	34.6–35.5	14.8–15.3	16.8–17.2	8.0–8.3	9.7–10.0	4.5–4.7	9.7–10.0	8.7–8.9	10.7–11.2	10.5–10.8
minusculus (Placerville)		169.5	30	20.5	34.5	14.9	16.8	7.6	9.9	4.6	10.2	9.0	10.9	10.5
	2 ♂	164–175	30–30	20–21	34.0–34.9	14.7–15.0	16.3–17.2	7.3–7.8	9.7–10.0	4.3–4.8	9.9–10.4	8.8–9.1	10.8–11.0	10.4–10.6
sericatus (Yosemite)		164.2	32.0	21.1	34.1	14.9	16.5	7.5	9.7	4.2	10.1	9.0	10.8	10.4
	11 ♂	150–174	25–36	20–24	32.5–35.1	14.4–15.5	16.2–16.8	7.2–7.8	9.1–10.1	4.0–4.6	9.8–10.5	8.7–9.5	10.5–11.1	10.2–10.8
campi (Minkler)		161.5	34.3	19.5	34.5	15.5[2]	16.7[2]	7.9	10.5	4.6	9.7[2]	9.0	11.0	10.6
	4 ♂	156–170	32–38	19–20	34.3–34.8	15.3–15.6	16.4–17.0	7.8–8.0	10.3–10.6	4.5–4.6	9.6–9.8	9.0–9.0	10.7–11.1	10.5–10.7
monoensis (type loc.)		161.2	33.7	21.7	33.4	14.6	16.6	7.7	9.8	4.2	9.9	8.7	10.5	10.0
	6 ♂	150–170	31–36	21–22	32.8–34.1	14.5–14.8	16.3–17.0	7.4–7.9	9.5–10.4	4.1–4.3	9.5–10.1	8.3–9.1	10.3–10.8	9.9–10.1
grinnelli[4] (type loc.)		155.5	33	20.5	33.2	15.0	16.9	7.9	10.0	4.4	9.6	8.6	10.5	10.0
	2 ♂	155–156	21–35	20–21	33.2–33.2	14.8–15.2	16.6–17.1	7.9–7.9	9.9–10.0	4.3–4.5	9.5–9.7	8.5–8.6	10.5–10.5	10.0–10.0
occultus (Los Angeles Co.)		149.4	31.2	19	32.2	14.1	15.8	7.3	9.4	4.1	9.4	8.3	10.2	9.7
	7 ♂	132–157	27–34	18–21	30.9–32.6	13.7–14.6	15.3–16.3	7.2–7.4	9.0–9.8	4.0–4.4	9.3–9.8	7.9–8.5	9.9–10.5	9.4–9.9
anthonyi (La Grulla)		143	32	18.2	30.9	13.9	15.7	7.2	9.3	4.2	8.6	8.4	9.5	9.1
	3 ♂	141–146	30–34	18–18.5	30.3–31.9	13.4–14.5	15.6–16.0	7.0–7.4	9.1–9.4	4.1–4.3	8.3–8.9	8.2–8.7	9.4–9.5	9.0–9.3
caurinus (Laytonville)		178.3	34.3	22	36.5	16.0	17.3	8.2	10.2	4.6	10.5	9.6	11.4	10.8

caurinus (Laytonville)		178.3	34.3	22	36.5	16.0	17.3	8.2	10.2	4.6	10.5	9.6	11.4	10.8
	8 ♀	154–192	23–39	20–24	35.7–37.3	15.4–16.7	16.8–17.7	7.7–8.4	9.8–10.5	4.4–4.8	10.1–11.0	9.4–9.8	11.2–11.6	10.6–11.2
insularis	1 ♀	182	36	22.5	35.8	16.0	18.0	8.4	10.4	4.8	10.5	9.1	11.3	10.9
latimanus (San Mateo Co.)		171[1]	38.5[1]	20[1]	34.3	15.2	16.7	7.9	9.9	4.5	10.0	9.0	10.8	10.4
	4 ♀	170–172	32–45	20–20	33.8–35.0	14.7–15.8	16.1–17.6	7.4–8.4	9.7–10.3	4.3–4.7	9.8–10.2	8.5–9.5	10.7–11.0	10.2–10.6
parvus (topotype)	1 ♀	159	30	20 (s. u.)	32.8	14.2	16.4	7.6	9.6	4.6	10.0	8.9	10.2	9.4
dilatus (nr. Lassen Peak)		167	34.6	22	34.6	15.3	16.6	8.0	9.5	4.4	9.9	8.4	10.8	10.3
	5 ♀	152–183	29–43	21–23	33.9–35.2	15.0–15.8	16.3–17.1	7.8–8.3	9.4–9.8	4.3–4.4	9.4–10.2	8.1–9.3	10.6–11.1	10.2–10.5
minusculus (Placerville)	1 ♀				34.0	15.1	16.3	7.6	9.5	4.5	9.7	8.7		10.0
sericatus (Yosemite)		161.7	32.1	21.1	33.7	14.9		7.5	9.6	4.3	9.7	8.6	10.7	10.4
	7 ♀	152–171	27–35	19–22	33.1–34.7	14.4–15.4		7.3–7.7	9.4–9.8	4.2–4.4	9.3–10.3	8.3–8.8	10.4–11.1	10.0–10.6
campi (Minkler)		151.3	28.8	20	33.4	15.0	16.3	7.8	10.1	4.4	9.5[5]	8.5	10.6	10.4
	4 ♀	140–160	26–32	19–21	33.0–33.7	14.8–15.2	16.1–16.6	7.6–7.9	9.8–10.4	4.3–4.4	9.4–9.8	8.2–8.9	10.5–10.7	10.3–10.4
monoensis (type loc.)		149.8	32.7	20.3	32.8	14.6	16.2	7.5	9.7	4.1	9.3	8.6	10.4	10.0
	6 ♀	136–161	29–36	20–22	31.8–33.7	14.2–15.0	15.9–16.5	7.3–7.8	9.4–10.1	4.0–4.3	9.0–9.6	8.2–9.0	10.2–10.6	9.6–10.4
grinnelli (type loc.)		156.8	32.2	20.3	32.5	14.5	16.5	7.8	9.9	4.3	9.4	8.3	10.4	9.9
	5 ♀	147–168	26–36	20–21	32.0–33.3	13.9–14.9	16.2–16.6	7.7–7.9	9.8–10.0	4.3–4.4	8.8–9.8	8.0–8.8	10.0–10.6	9.6–10.1
occultus (Los Angeles Co.)		152.2	29.3	19.3	31.7	13.7	15.9	7.3	9.2	4.1	9.3	8.1	9.9	9.5
	6 ♀	140–161	25–34	18–20	30.3–33.1	13.1–14.5	15.4–16.1	6.9–7.7	8.9–9.5	3.9–4.2	9.0–9.8	7.6–8.8	9.4–10.4	9.0–9.9
anthonyi (La Encantada)	1 ♀	143	31	19	29.7	13.2	15.3	6.9	8.9	3.6	8.6	8.2	8.6	8 8

[1] Measurements for 2 specimens only.
[2] Measurements for 3 specimens only.
[3] Measurements for 3 specimens only, which are flatter than typical.
[4] One from 7 mi. N. of type locality.
[5] Flatter than typical.

In this study, two virtual topotypes of *alpinus*, old male and female adults, from one mile south of Crater Lake, Oregon (Dickey coll.), were examined. The type of *alpinus* was not seen by the writer. These two specimens are definitely intergrades between *caurinus* and *dilatus*. In size, they approach *caurinus*, especially in length of hind foot, although individuals of *dilatus* may be as large. In color, they are definitely pale, as in *dilatus*. The size of skull is much smaller than in *caurinus* and size and general conformation of the skulls are, as in *dilatus*, especially noticeable in shorter and relatively broader rostrum and relatively broader maxillary region. The braincase of the male is as narrow as in typical *caurinus* but that of the female is as broad as in typical *dilatus*. Another character that indicates relationship with *caurinus* is the relatively long, narrow orbits which appear to be typical of *caurinus*. Most of the characters, however, indicate affinities with *dilatus*. This is what one would expect from examination of other intergrades to the southwest; specimens nearer the coast, as at Medford, Jackson County, Oregon, show more characters of *caurinus* than do these, but are referred to *dilatus*, while those still farther to the southwest and nearer the coast are nearly typical *caurinus*.

Jackson had only the type of *alpinus* for examination and noted (1915, p. 75) that "The subspecies *alpinus* is a poorly differentiated form having the color of *S. l. dilatus* and the size and skull proportions of large specimens of *S. l. latimanus* [= *caurinus*]; it is not strictly intermediate between these two forms, however, since specimens of *latimanus* [= *caurinus* of present treatment] from southwest of Klamath Lake do not reach the maximum size." Now, however, it appears that the large size is not diagnostic, for there are specimens of *dilatus* from Hornbrook, Siskiyou County, and Lake City, Modoc County, whose measurements equal or exceed those given by Jackson for the skull of the type of *alpinus*. The skulls of the topotypes are no larger than in typical *dilatus* and are markedly smaller than the type. Jackson also regarded as diagnostic the narrowness of the skull of the type in comparison with *dilatus*. This character the writer regards as one belonging to *caurinus* and indicating intergradation. Another diagnostic character given by Jackson is that the skull is flatter than in *dilatus*, but since the type is a very old male, this probably is only an age character. The two topotypes, although both adult, have skulls no more flattened than similarly aged individuals of *dilatus* and *caurinus*. The writer has failed to find any characters for the subspecies *alpinus* that are not possessed by either *dilatus* or *caurinus*. All features considered, the population at the type locality is more like *dilatus*, in the synonymy of which the name *alpinus* is placed.

Intergradation with *caurinus* is indicated also by specimens from south-central Oregon and extreme north-central California. Specimens from near Medford, Jackson County, Oregon, in fresh pelage have the typical dark color of *caurinus*, but are paler in worn pelage and the skulls are nearly typical of *dilatus;* therefore, they are here referred to *dilatus*. Specimens from the eastern part of the Siskiyou Mountains in Siskiyou County, California, have the typical grayish coloration of *dilatus*, but those from the western end of this region are slightly darker and more brownish. There is also a gradual decrease in length of skull and an increase in mastoidal and maxillary breadths from west to east in this region. Specimens from the western end of the Siskiyou Mountains as at Poker Flat, 5000 feet, 12 miles northwest of Happy Camp, Siskiyou County, California, are referred to *caurinus* on skull characters and slightly darker color. Those from the more eastern part of this range, as at Donomore Meadow, 15 miles west of Hilt, and Head of Doggett Creek [Deer Camp], are referred to *dilatus*. Specimens from Hornbrook, Siskiyou County, have skulls larger than those from the Siskiyou Mountains, but ratios of skull measurements are like those from the eastern part of the range and the color of pelage is identical. Specimens from an area around the upper end of the Sacramento Valley, as at McCloud River near Baird Station and Tower House, Shasta

County, probably also show intergradation with *caurinus*. These are pale in color but the skulls are narrower than in typical *dilatus*.

Intergradation with *minusculus* may occur at the southwestern limits of the range. Specimens from Placer County, as at Tahoe City, Lake Tahoe, and Applegate, have skulls typical of *dilatus* but approach in color the dark brown of *minusculus*.

Specimens from the southern and eastern parts of the range, as at Eagle Lake and Cromberg, California, and 3 miles west of Reno, Nevada, have shorter and broader skulls than specimens from the northern and western parts of the range. This possibly indicates intergradation with *monoensis*.

Specimens examined.—Total number 68, as follows: **Oregon:** *Klamath Co.:* 1 mi. S. Crater Lake, 2 (Dickey); Camp Ground, south end Lake of the Woods, 5025 ft., 1. *Jackson Co.:* 6 mi. S. Medford, 1600 ft., 8; Southern Oregon Experiment Station, near Talent, 1. **California:** *Siskiyou Co.:* Donomore Meadow, 5800 ft., 15 mi. W. Hilt, 1. Head of Doggett Creek [Deer Camp], 5800 ft., 2; Klamath River, 2100 ft., 2 mi. S. Hornbrook, 6; Sisson, 3600–3700 ft., 8 (2 Dickey). *Modoc Co.:* Lassen Creek, 5 (Dickey); Lake City, 3; Parker Creek, 5500 ft., Warner Mountains, 1; no exact locality, Warner Mountains, 7000 ft., 1 (Los Angeles Mus.); Cedarville, 1; Eagleville, 4 (Calif. Acad. Sci.). *Shasta Co.:* Crystal Creek, 20 mi. W. Redding, 2500 ft., 1; Tower House, 1; McCloud River, near Baird Station, 1; Lake Helen, 8500 ft., 1. *Lassen Co.:* Eagle Lake Resort, Eagle Lake, 5125–5150 ft., 5; 5 mi. N. Fredonyer Peak, 5700 ft., 2. *Tehama Co.:* Dale's on Paine's Creek, 600 ft., 3; Lyman's, 4 mi. N. W. Lyonsville P. O., 3300 ft., 1; Lyonsville, 3500 ft., 1; Battle Creek Meadows, 4800 ft., 1; Mineral Ranger Station, 5000 ft., 1. *Plumas Co.:* Hot Springs Valley, 5200 ft., 1; Cromberg, Middle Fork Feather River, 4750 ft., 1. *Nevada Co.:* Nevada City, 1. *Placer Co.:* Applegate, 1 (Calif. Acad. Sci.); Tahoe City, Lake Tahoe, 1. **Nevada:** *Washoe Co.:* 12-mi. Creek, 1.5 mi. E. Calif. line, 5300 ft., 1; W. side Truckee River, 4900 ft., 0.5 mi. W. Verdi, 1; 3 mi. W. Reno, 2; Marlette Lake, 1.

Scapanus latimanus insularis new subsp.

Type.—Adult, male, skin and skull; no. 68,993, Mus. Vert. Zool.; Angel Island, San Francisco Bay, Marin County, California; October 20, 1935; collected by F. G. Palmer, orig. no. 767.

Range.—Confined to Angel Island, altitudinal range from near sea level to about 760 feet. Zonal range, Upper Sonoran and weak Transition.

Diagnosis.—Size: Large (see measurements), nearest to *caurinus* in size. Color: Dark, almost black. Skull: Long (see measurements), heavily built, and relatively broad, with rostrum short and broad (average rostral breadth greater than 13.4 per cent of greatest length of skull); frontal region inflated and interorbital region extremely broad (average interorbital breadth greater than 23 per cent of greatest length); braincase broad (average mastoidal breadth greater than 50 per cent of greatest length), flattened, and somewhat truncate posteriorly.

Color.—In slightly worn winter pelage, near Fuscous above; Hair Brown to Mouse Gray below. In fresh summer pelage, Fuscous Black toward black above; Dark Mouse Gray or between Chaetura Drab and Chaetura Black below. In somewhat worn summer pelage, Mummy Brown above, slightly lighter below, stained on midventral line with Cinnamon Brown.

Comparisons.—This mole is most similar to the races *caurinus*, *latimanus*, and *parvus*, its nearest geographic neighbors.

Compared with *caurinus*, *insularis* is of about the same size and color. Skulls of *insularis* are easily distinguished by their shorter and relatively much heavier rostrum; relatively broader maxillary region, and more inflated frontal region; much broader interorbital region; relatively much broader braincase through the mastoid region; and braincase truncate posteriorly. (See Table 1.)

Compared with *latimanus*, *insularis* is larger, with larger feet and heavier claws on forefeet, and is only slightly darker in color. The skull is larger and more massive, with relatively broader rostrum and maxillary region; much broader interorbital region; relatively larger orbits; and broader and more truncate braincase. See also *Diagnosis* for *insularis*, and Table 1.

Compared with *parvus* from Alameda, *insularis* is much larger and darker. The skull has many of the same characters but they are developed to a lesser degree and the skull is decidedly larger, with comparatively narrower interorbital breadth, shorter palatal length, and with the braincase more flattened and truncate.

Remarks.—Angel Island, although comprising an area of only about one square mile, supports a large population of moles. Mole mounds and surface ridges were common in October, 1935, and March, 1936, in all parts of the island, especially on the northern side where the soil is moister and where there is much chaparral. The vegetation is similar to that in the Berkeley hills where *latimanus* is common.

Because this subspecies is situated geographically between *caurinus* and *latimanus*, one might expect it to be intermediate in characters. It differs markedly, however, from each subspecies in skull characters; more so than *caurinus* and *latimanus* do from one another. In external characters, which are probably most influenced by climatic factors, *insularis* approaches *caurinus*, to which it is nearest geographically. On the basis of skull characters, however, it shows closer affinities with *latimanus*.

There is slight individual variation in *insularis*, especially in the size of the skull. Certain specimens in the collection of the California Academy of Sciences differ from the others markedly in size. Proportions or ratios hold very well, however, and subspecific characters are well shown in all the specimens except one, a female (no. 2410, Calif. Acad. Sci.). The skull of this specimen is broken and only a few measurements can be taken, but it appears to be smaller than the others and does not equal them in width. In addition, the feet in the dried skin are appreciably smaller and claws on the forefeet are more slender and pointed. There is a chance that this specimen was not collected on Angel Island, since confusion of other data relating to this specimen is known to have occurred.

Specimens examined.—Nine from the type locality (Calif. Acad. Sci.: 1 skin and skull, 3 skins-only, 2 skulls-only. Mus. Vert. Zool.: 3 skins and skulls).

Scapanus latimanus latimanus (Bachman)

Scalops latimanus Bachman, Boston Jour. Nat. Hist., vol. 4, p. 34, 1842 (orig. desc.).

Scalops californicus Ayres, Proc. California Acad. Sci., vol. 1, p. 54, 1856 (type loc. San Francisco, California).

Scalops (*Scapanus*) *townsendii*, Baird, U. S. Pacific R. R. Expl. and Surv., vol. 8 (part 1), p. 65, 1857 (part).

Scapanus Townsendi, Peters, Monatsber. K. Preuss. Akad. Wiss. Berlin, 1863, p. 656, 1864 (part).

Scapanus californicus, True, Proc. U. S. Nat. Mus., vol. 19, p. 52, 1896.

Scapanus latimanus, Osgood, Proc. Biol. Soc. Washington, vol. 20, p. 52, 1907.

Scapanus latimanus latimanus, Grinnell and Swarth, Univ. California Publ. Zool., vol. 10, p. 131, 1912.

Type.—Mounted specimen with imperfect skull, Berlin Museum; probably from Santa Clara, Santa Clara County, California; collected in October, 1834 (*fide* Osgood, 1907, p. 52).

Range.—Coastal region of California south of San Francisco Bay and entirely west of the San Joaquin Valley, south at least to Santa Margarita, San Luis Obispo County. Altitudinally from near sea level (Seaside, Monterey County) to 4400 feet (San Benito Mountain, San Benito County). Zonal range, Lower Sonoran through Transition.

Diagnosis.—Size: Moderately large (see measurements). Color: Dark, generally Fuscous to Fuscous Black. Skull: Moderately large, broad and heavy; with short, broad rostrum (rostral breadth averaging more than 13 per cent of greatest length of skull); heavy sub-lacrimal maxillary ridges; short broad palate (maxillary breadth 29 per cent or more of greatest length of skull), with sharp bend in upper tooth-row and teeth crowded; broad interorbital region; large orbits, the zygomatic arches heavy and bowed outward; broad, somewhat flattened braincase (mastoidal breadth about 49 per cent of greatest length of skull).

Color.—In fresh winter pelage, near Fuscous, Fuscous Black, or Chaetura Black above; slightly lighter below, generally near Chaetura Drab. In worn winter pelage, Prout's Brown, Mummy Brown or near Fuscous above; Drab, Mouse Gray or Chaetura Drab below. In fresh summer pelage, generally between Olive Brown and Clove Brown above, some darker (near Fuscous), or lighter (near Drab); Hair Brown to Mouse Gray below. In worn summer pelage, paler and more brassy, Snuff Brown, Saccardo's Umber or Buffy Brown above; Hair Brown to Drab below, commonly stained on midventral line with Tawny Olive or Dresden Brown.

Comparisons.—From *caurinus*, occupying the coast region north of San Francisco Bay, *latimanus* can be distinguished by smaller size (hind foot averaging less than 23 mm. in *latimanus* and more than 23 in *caurinus*, and shorter, broader skull (average greatest length less than 36.0 in males and 35.2 in females). For further comparison see under the account of *caurinus*.

Compared with *insularis* from Angel Island, San Francisco Bay, *latimanus* is smaller; has much the same color; a shorter, less massive skull which is narrower throughout, the ratio of all breadth measurements to greatest length being appreciably less. For more detailed comparison see account of *insularis*.

S. l. latimanus is easily distinguished from *parvus* from Alameda, Alameda County, by larger size, somewhat darker color and in having skull markedly longer and relatively narrower throughout. For further comparison see account of *parvus* and Table 1.

S. l. latimanus can be distinguished from *campi* by larger size, darker color, broader, more tapering rostrum, lesser relative maxillary breadth, lighter sublacrimal ridges, narrower interorbital region, less inflated braincase in mastoidal region, and braincase less rounded posteriorly.

From *occultus* of the southern California region, *latimanus* is distinguishable on external characters by larger size and darker color, especially in winter pelage. The skull is much larger (greatest length of *occultus* equals 91 per cent of greatest length for *latimanus*), with: Shorter, broader rostrum (rostral breadth in males more than 13.0 per cent of greatest length); relatively longer orbits; relatively narrower interorbital region and braincase (mastoidal breadth less than 49 per cent of greatest length in *latimanus*, more than 49 per cent in *occultus*); relatively shallower braincase, and more widely spreading zygomatic arches.

Remarks.—The subspecies *latimanus* shows but little variation over a large area. Among the populations showing slight variations from the mean is the series from the vicinity of Santa Cruz, Santa Cruz County, whose skulls average larger. Slight variations in color are apparent here and there, but the average tone is quite constant except for individuals from the region south of Monterey Bay. These are paler in fresh pelage and more reddish in worn pelage than typical specimens from farther north. They are also more reddish than any specimens of *occultus* to the south, and resemble *campi* from the San Joaquin Valley to the east.

The specimen furnishing the easternmost record of occurrence is a subadult female from Walnut Grove, Sacramento County. This is the only specimen known to the writer from the Sacramento-San Joaquin Valley between Red Bluff, Tehama County, and Snelling, Merced County. This female is typical of *latimanus* in color and in body

measurements but differs in certain skull characters. These are: Slightly smaller size; relatively greater palatal length; a distinct interorbital constriction; more angular mastoid region; relatively narrower braincase with posterior part more pointed (less rounded). The skull has only one of the characters that distinguish *campi* from *latimanus*, that of smaller size. A series of moles from this locality might show differential characters of subspecific value.

Intergradation with *occultus* is indicated by a specimen from Santa Margarita, San Luis Obispo County, as has already been recorded by Grinnell and Swarth (1912, p. 133) and Jackson (1915, p. 67). It approaches *occultus* in smaller size and paler color. The skull is definitely referable to *latimanus*, but approaches *occultus* in smaller size, more flattened braincase, and straighter zygomatic arches. It differs slightly from both subspecies in relatively narrower mastoidal breadth and greater rostral breadth.

Five specimens from San Benito County are similar to the mole from Santa Margarita, and indicate intergradation with *occultus*. Two from one mile southeast of the summit of San Benito Mountain approach *occultus* in more characters than do 3 from the more western part of the county at Butts Ranch. Skulls of the 2 from San Benito Mountain are only slightly larger than *occultus* and approach *occultus*, and differ from *latimanus* in certain proportions, which are: Shorter orbits; 'weaker' zygomatic arches; relatively broader braincase; narrower rostrum. They definitely belong to *latimanus*, however, rather than to *occultus*. They show no closer approach to *campi* in characters than do moles from the Salinas Valley.

S. l. latimanus has not been demonstrated to intergrade with any subspecies other than *occultus*, but intergradation with *campi* may take place at the northern and western margins of the San Joaquin Valley.

Specimens examined.—Total number 127, all from California and, unless otherwise indicated, in the Museum of Vertebrate Zoology: *Contra Costa Co.:* Pinole, 1; Lafayette, 8; Walnut Creek, 2; 8 mi. E. Clayton, 1; Wildcat Canyon, Berkeley Hills, 2. *Alameda Co.:* Berkeley, 29 (1[1]); Claremont Canyon, 1; Oakland, 2 (1[2]); San Leandro, 6; Hayward, 2. *San Francisco Co.:* Presidio, San Francisco, 2; Golden Gate Park, San Francisco, 15 (13[3]). *San Mateo Co.:* Burlingame, 1[2]; Redwood City, 7[2]; Baden, 1; La Honda, 2; Menlo Park, 12 (3[3]); San Gregorio, 1[3]. *Santa Clara Co.:* Palo Alto, 1; Stanford Univ., 2; 3 mi. S. Morgan Hill, 1. *Santa Cruz Co.:* Santa Cruz, 1; 2–4 mi. E. Santa Cruz, 11 (5[1]); 1 mi. E. Aptos, 2. *Monterey Co.:* Seaside, 7; 2 mi. E. San Lucas, 2; 2 mi. E. Bryson, 1. *San Benito Co.:* Butts Ranch, 3000 ft., 5 mi. N. N. E. San Benito, 3; 1 mi. S. E. summit San Benito Mtn., 4400 ft., 2. *San Luis Obispo Co.:* Santa Margarita, 1.

Scapanus latimanus parvus new subsp.

Type.—Adult, male, skin and skull; no. 30,343, Mus. Vert. Zool.; Alameda, Alameda County, California; June 1, 1916; collected by M. P. Anderson, orig. no. 37.

Range.—So far as known, confined to the island of Alameda, San Francisco Bay, California. Altitudinal range all within a few feet of sea level. Zonal range, Upper Sonoran.

Diagnosis.—Size: Small, total length less than 160 mm. Color: Moderately dark. Skull: Short (greatest length less than 33 mm.) and very broad, with long rostrum that is relatively broader than in any other subspecies (average rostral breadth equalling 14 per cent of greatest length); palate short and relatively broad (average maxillary breadth more than 29 per cent of greatest length); interorbital breadth relatively great

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[1] Ralph Ellis.
[2] San Diego Soc. Nat. Hist.
[3] Calif. Acad. Sci.

(averaging 23.2 per cent of greatest length of skull); ratio of mastoidal breadth to greatest length of skull maximum for the species *latimanus* (51.2 per cent in the male and 50 per cent in the female); braincase somewhat inflated.

Color.—Type, in fresh summer pelage, near Clove Brown above; Hair Brown to Mouse Gray below. Topotype, in worn winter pelage, between Bone Brown and Clove Brown above, Hair Brown below.

Comparisons.—The small size and short, broad skull are sufficient to distinguish this subspecies from *latimanus* from the nearby mainland. For further comparison with *latimanus* see Table 1.

From *insularis*, which occupies another island in San Francisco Bay, *parvus* may be distinguished by much smaller size (see measurements), paler color, and shorter, and relatively slightly broader skull. For the skulls, the ratios of width measurements to greatest length in *parvus* are much as in *insularis* but average slightly greater except in the interorbital region, palatal length is relatively shorter, and the braincase is more inflated and less truncate posteriorly.

Remarks.—This subspecies is based upon two adult specimens, male and female, which are the only specimens known to the writer from Alameda. The island is isolated only by a narrow estuary or tidal slough. Probably *parvus* is confined to the island of Alameda, but possibly it occupies the marshy areas around the eastern and southern margins of San Francisco Bay. No moles have as yet been collected in that region. If this is a salt marsh form, the genus *Scapanus* would parallel certain other genera of mammals of the region—*Sorex*, *Reithrodontomys*, and *Microtus*—each of which also has a salt marsh form and an upland form around the southern and eastern edges of San Francisco Bay.

Specimens examined.—Two from the type locality.

Scapanus latimanus minusculus Bangs

Scapanus californicus minusculus Bangs, Proc. New England Zool. Club, vol. 1, pp. 70-71, July 31, 1899 (orig. desc.).

Scapanus latimanus minusculus, Grinnell and Swarth, Univ. California Publ. Zool., vol. 10, p. 133, 1912.

Scapanus latimanus latimanus, Grinnell, Proc. California Acad. Sci., vol. 3, p. 269, 1913 (part).

Scapanus latimanus minusculus, Jackson, Proc. Biol. Soc. Washington, vol. 27, p. 55, 1914.

Type.—Subadult, female; skin and skull; no. 9189, Mus. Comp. Zool., Bangs Collection; Fyffe, 3500 feet altitude, Eldorado County, California; July 15, 1897; collected by W. W. Price and E. M. Nutting (*fide* Bangs, 1899, p. 70).

Range.—Known only from a very restricted range from Placerville, Eldorado County, east to the type locality. Altitudinal range from 2000 feet (as at Placerville) to 3500 feet (as at type locality). Zonal range, chiefly Transition.

Diagnosis.—Size: Medium (see measurements). Color: Dark Brown. Skull: Of medium size (see measurements) with short, broad rostrum; heavy sublacrimal-maxillary ridges; broad interorbital region; and broad, inflated braincase.

Color.—In slightly worn winter pelage, Bone Brown to Fuscous above; slightly lighter below, tinged along midventral line with Saccardo's Umber. In very worn winter pelage, between Hair Brown and Benzo Brown above; Mouse Gray to Deep Mouse Gray below, paling in a few spots to Drab.

Comparisons.—Compared with *dilatus*, *minusculus* is only slightly smaller and darker than the darkest specimens in unworn and unfaded pelage. The skull of *minusculus* differs from the typical skull of *dilatus* in shorter, broader rostrum; broader interorbital region; broader mastoidal region and more inflated braincase. It resembles, in some

ways, specimens of *dilatus* from Cromberg, Plumas County, and Eagle Lake, Lassen County. Moles from Applegate, and Tahoe City, Placer County, appear to be intermediate between this race and *dilatus*. They are nearly typical of *minusculus* in color but are referred to *dilatus* on skull characters which do not approach those of *minusculus*.

Compared with *sericatus* from Yosemite, *minusculus* is of almost exactly the same size and color. On the basis of skull characters, some of the specimens of *minusculus* might be referred to *sericatus*. Typical specimens, however, differ in being broader throughout, with shorter rostrum, less sharply bent upper tooth-rows, and higher, more inflated braincase.

From *monoensis* of the east side of the Sierra Nevada, *minusculus* differs in having greater total length but shorter tail, broader forefeet, and slightly darker color (comparison is possible, because of limited material, only in worn summer pelage). Skulls differ in larger size, shorter and relatively broader rostrum, with interorbital region more constricted, and more inflated braincase.

Remarks.—This race has caused the writer more difficulty than any other included in this study, and is only tentatively recognized here. Material is insufficient to show whether the specimens examined pertain to a distinct subspecies or are merely intergrades between *sericatus* and *dilatus*, as is suggested by their size, color, and skull characters.

The subspecies was originally described by Bangs (1899, pp. 70–71) from a single specimen, a "young adult female." The description of the diagnostic skull characters as given by Bangs and description and plates in Jackson (1915, p. 72 and pls. 4, 6) suggest to me that the type is young. Several of the characters seem to be more indicative of immaturity than of geographic variation.

No topotypic specimens have been seen by the writer, and the present description is based on specimens from Placerville and 4 miles east of Placerville, Eldorado County. The last named locality is about 6.5 miles airline from the type locality and about 1000 feet lower in altitude. These specimens average larger than the type (Jackson and Bangs do not agree in all measurements of it). Also, these specimens are in winter pelage, which is generally darker than "hair brown above and deep mouse gray below," as recorded for the type by Jackson. Specimens examined vary widely in size and proportions of skulls; some are malformed and distinctly abnormal. The only skull that appears to be entirely normal, an adult male, no. 27,857, has been used in the diagnosis and comparisons.

Two specimens referred to *sericatus* from Twain Harte P. O., 4000 ft., Tuolumne County, show some approach toward *minusculus* in browner color and shorter rostrum, but are typical of *sericatus* in all other characters.

Specimens examined.—Total number 5, all from California: *Eldorado Co.:* Placerville, 4; 4 mi. E. Placerville, 1.

Scapanus latimanus campi Grinnell and Storer

Scapanus latimanus occultus, Jackson, North Amer. Fauna, no. 38, p. 69, 1915 (part).

Scapanus latimanus campi Grinnell and Storer, Univ. California Publ. Zool., vol. 17, pp. 1–2, August 23, 1916 (orig. desc.).

Type.—Adult male, skin and skull; no. 21,520, Mus. Vert. Zool., Snelling, 250 ft. altitude, Merced County, California; January 9, 1915; collected by Charles L. Camp; orig. no. 1746.

Range.—East side of the San Joaquin Valley and lower slopes of Sierran foothills from Snelling, Merced County, and El Portal, Mariposa County, southeast to Dunlap, Fresno County. Altitudinal range from 200 ft. (Minkler) to 2000 ft. (Dunlap). Zonal range, Lower and Upper Sonoran.

Diagnosis.—Size: Medium (see measurements). Color: Pale and brownish; in fresh

winter pelage near Dresden Brown. Skull: Size medium, with rostrum nearly parallel-sided; relative maxillary breadth great and sublacrimal-maxillary ridges heavy; frontal region inflated; interorbital region relatively broad; orbits short, with zygomata sharply bent at anterior end; braincase rounded rather than angular at mastoid region and rounded posteriorly.

Color.—In winter pelage, near Dresden Brown above; Drab below, with Antique Brown on the chin. In fresh summer pelage, darkest between Dresden Brown and Cinnamon Brown; palest between Wood Brown and Buffy Brown. In worn summer pelage, darkest near Prout's Brown above, lighter below, near Dresden Brown; palest Buckthorn Brown to Tawny Olive above, paler below.

Comparisons.—This race is most like *sericatus* in size of body, and in size and general conformation of the skull. It is lighter colored, however, and the skull is broader, more heavily built, and less angular. Both races are characterized by a long, rather narrow, nearly parallel-sided rostrum with broad palate (or maxillary region) so that there is a sharp bend in the upper tooth-row, but this is more highly developed in *campi* since it has the greater maxillary breadth. The skull of *campi* is wider also in the interorbital region, but is only slightly greater in mastoidal breadth, and the braincase is rounded posteriorly rather than angular.

From *occultus*, *campi* can be separated on the basis of larger size, generally paler color, and certain proportions of the skull. In color, *campi* is paler in winter pelage and the summer pelage is a richer brown (less grayish). There is but little overlapping in body measurements between the largest *occultus* and the smallest *campi*, and there is no overlap in the measurements of typical skulls. Skulls of *campi* have: Rostrum longer, broader, and less tapering; maxillary breadth relatively greater; upper tooth rows with sharper bend; mastoidal breadth comparatively slightly less.

For comparison with *latimanus* see the account of that race and Table 1.

Remarks.—This subspecies intergrades with *sericatus* in the foothills of the Sierra Nevada. One specimen (not sexed, but probably female) from El Portal, 2000 feet altitude, Mariposa County, is clearly intermediate between *campi* and *sericatus*. Its skull agrees in almost all characters with females of *campi* and it is referred to that race, although color of pelage is much darker and is nearly typical of *sericatus*. Two subadult males from 3 miles northeast of Coulterville approach *campi* in greater mastoidal breadth and more inflated braincase, but are typical of *sericatus* in all other characters. Jackson (1915) recorded a specimen of *sericatus* from Bower Cave, Mariposa County, that probably also shows evidence of intergradation.

Intergradation with *occultus* is clearly indicated by a series of 8 specimens from Kings River Canyon, 5000 feet altitude, Fresno County. Four of these are typical *occultus*, except for slightly darker pelage, 2 are typical *campi* except for smaller size of skulls, and 2 are intermediate in proportions of skulls between *campi* and *occultus*.

Indication of intergradation with *latimanus* is furnished by several specimens from the Salinas Valley and the south coast ranges in San Benito and Monterey counties. These specimens are similar to *campi* in color of pelage, both winter and summer, and the skulls are of almost exactly the same size, but the shape is as in *latimanus*.

Specimens from the type locality, and from Minkler, agree in size, color, and in nearly all skull characters. Skulls of moles from Minkler, however, are more flattened, with braincase less inflated, but with the frontal region more inflated, and they also show a tendency toward greater rostral width. I believe that skulls of specimens from Minkler are more nearly typical of the race.

Specimens examined.—Total number 15, all from California: *Merced Co.:* Snelling, 250 ft., 4. *Mariposa Co.:* El Portal, 2000 ft., 1. *Fresno Co.:* 3 mi. N. Sanger, 1; Minkler, 200 ft., 8; Dunlap, 2000 ft., 1.

Scapanus latimanus sericatus Jackson

Scapanus latimanus minusculus, Grinnell and Swarth, Univ. California Publ. Zool., vol. 10, p. 133, 1912 (part).

Scapanus latimanus latimanus, Grinnell, Proc. California Acad. Sci., vol. 3, p. 269, 1913 (part).

Scapanus latimanus sericatus Jackson, Proc. Biol. Soc. Washington, vol. 27, p. 55, March 20, 1914 (orig. desc.).

Type.—Female adult, skin and skull; no. 109,548, U. S. National Museum, Biological Survey Collection; Yosemite, Yosemite Valley, Mariposa County, California; August 20, 1901; collected by W. K. Fisher, orig. no. 2227. (*Fide* Jackson, 1914, p. 55.)

Range.—Western slope of the Sierra Nevada of California from Twain Harte Post Office, Tuolumne County, southwest to vicinity of Coulterville; east to Tuolumne Meadows, Tuolumne County; south in the Sierra to Shaver Ranger Station, Fresno County. Altitudinal range from 3200 to 9500 feet (in Lyell Canyon, Yosemite National Park, Tuolumne County: Grinnell and Storer, 1924, p. 43). Zonal Range, Transition to Hudsonian.

Diagnosis.—Size: Medium (see measurements). Color: Dark. Skull: Long, narrow, angular; rostrum long and narrow, nearly parallel-sided but flaring widely at juncture with the maxillae to give a sharp bend in the upper tooth-rows; interorbital region narrow; braincase narrow (flattened and angular in old adult specimens).

Color.—In fresh winter pelage, Fuscous to Fuscous Black above; Deep Mouse Gray below. In worn winter pelage, Fuscous to Fuscous Black above; underparts near Hair Brown to Deep Mouse Gray. In fresh summer pelage, darkest, near Olive Brown above, Mouse Gray to Deep Mouse Gray below, palest, Drab to Hair Brown above, near Mouse Gray below. In worn summer pelage, Hair Brown above; Deep Mouse Gray below.

Comparisons.—In comparison with *campi*, the adjoining race on the west, *sericatus*, is of similar size externally, is much darker colored and has a narrower skull as shown by all breadth measurements except that across the mastoidal region. For further comparison see the account of *campi*.

Compared with *monoensis*, its near neighbor to the east, *sericatus* is larger, darker,

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PLATE 1

Dorsal view of the skulls of subspecies of *Scapanus latimanus*, natural size (× 1).

1. *S. l. caurinus*, no. 25,388, ♂; Laytonville, Mendocino Co., Calif. (type).
2. *S. l. insularis*, no. 68,993, ♂; Angel Island, San Francisco Bay, Marin Co., Calif. (type).
3. *S. l. latimanus*, no. 18,777, ♂; Menlo Park, San Mateo Co., Calif.
4. *S. l. parvus*, no. 30,343, ♂; Alameda, Alameda Co., Calif. (type).
5. *S. l. dilatus*, no. 54,896, ♂; Camp Ground, south end Lake of the Woods, 5025 ft. alt., Klamath Co., Ore.
6. *S. l. minusculus*, no. 27,857, ♂; 4 miles east of Placerville, Eldorado Co., Calif.
7. *S. l. sericatus*, no. 12,980, ♀; Yosemite Valley, 4000 ft. alt., Mariposa Co., Calif.
8. *S. l. campi*, no. 21,520, ♂; Snelling, 250 ft. alt., Merced Co., Calif. (type).
9. *S. l. monoensis*, no. 25,834, ♀; Taylor Ranch, 5300 ft. alt., 2 mi. S. of Benton Station, Mono Co., Calif. (type).
10. *S. l. grinnelli*, no. 17,785, ♂; site of old Fort Independence (on ranch of Carl Walters), 2 mi. N. of Independence, 3900 ft. alt., Inyo Co., Calif. (type).
11. *S. l. occultus*, no. 2369, ♀; Santa Ana Canyon, 400 ft. alt., [12 mi. N. E. of Santa Ana], Orange Co., Calif. (type).
12. *S. l. anthonyi*, no. 36,008, ♂; La Grulla, 7200 ft. alt., Sierra San Pedro Martir, Lower Calif., Mexico.

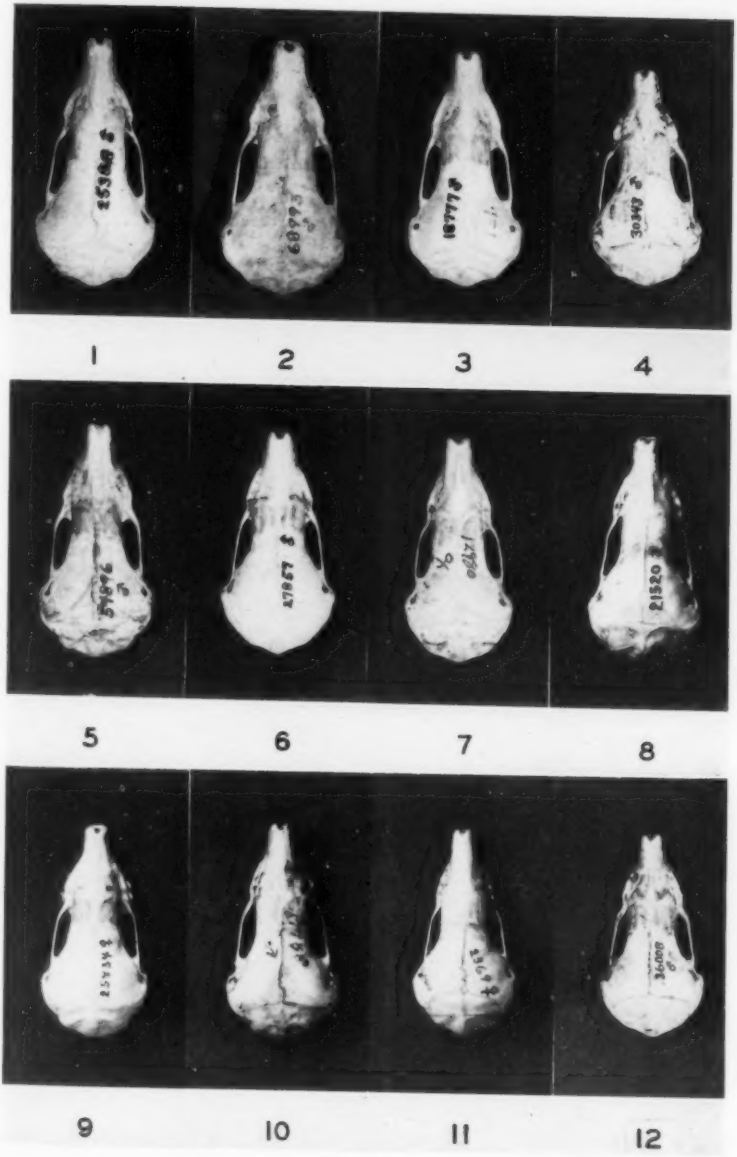

PLATE 1

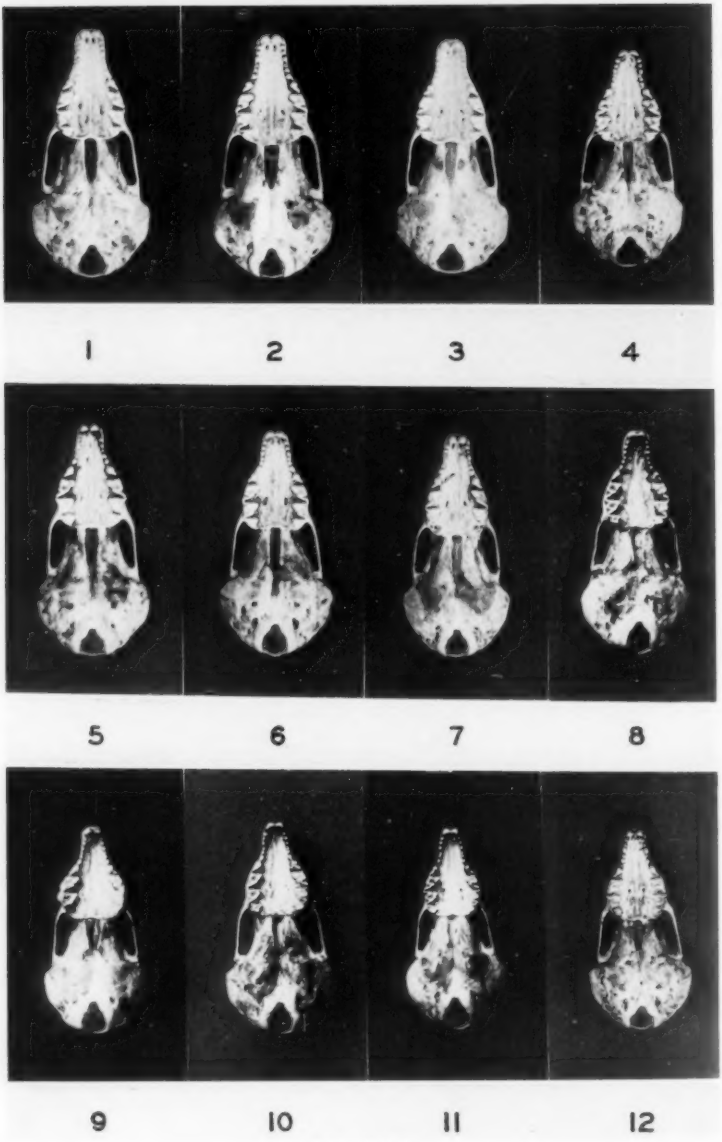

PLATE 2

Ventral views of the same skulls of subspecies of *Scapanus latimanus* as shown in Plate 1, in the same order, natural size.

and has a longer, comparatively narrower skull. For more complete comparison see account of *monoensis*.

Compared with *grinnelli*, *sericatus* is lighter colored, and has a longer body and hind foot. The skulls are widely different, that of *sericatus* being narrow and that of *grinnelli* broad. The skull of *sericatus* measures actually longer and narrower, the rostral breadth excepted. It follows that ratios of breadth measurements of the skull to its greatest length are greater in *grinnelli*. *S. l. sericatus* has a relatively longer, less tapering rostrum; 'weaker' zygomatic arches; more marked postorbital constriction; and less truncate braincase posteriorly. Viewed from below, *sericatus* has a much shallower groove between the bullae in the basioccipital region.

Compared with *occultus* from Los Angeles County, *sericatus* is much larger and somewhat darker, with longer, narrower skull. The skull of *occultus* is 'smoother' and less angular (most noticeable in old adults), with relatively narrower, shorter rostrum; comparatively broader maxillary, interorbital, and mastoidal breadths; relatively much deeper, less angular, braincase.

Remarks.—The diagnostic characters for the subspecies *sericatus* are relatively constant, but there is some individual variation among the skulls of young adults. Some of these resemble skulls of *occultus* but they generally can be distinguished by larger size and relatively narrower braincase.

Two specimens from Twain Harte P. O., in browner color and shorter rostrum, suggest intergradation with *minusculus*. In all other characters, however, they approach typical *sericatus* from Yosemite Valley. Probably intermediates between the two races occur in the area not far north of the Twain Harte P. O.

Intergradation with *campi* is indicated by a number of specimens from the foothill region of the Sierra. Two young adult males from 3 miles northeast of Coulterville, here referred to *sericatus*, approach *campi* only in greater mastoidal breadth and slightly deeper, more inflated braincase. A specimen from El Portal, with all the skull characters of *campi*, is much darker than *campi* and nearly typical of *sericatus* in this respect. Jackson (1915, p. 71) recorded a mole from Bower Cave, Mariposa County, that he stated is: "... not typical of the subspecies [*sericatus*]; it has a shorter tail than specimens from the Yosemite Valley and the skull is flatter and wider through the braincase than that of typical *sericatus*." This specimen also apparently approaches *campi*.

Intergradation with *monoensis* is suggested by a male, from Porcupine Flat, that has broader mastoidal and interorbital breadths, more tapering rostrum, and shorter palate than typical. In color this specimen is nearly typical of *sericatus*. A female from Tuolumne Meadows is nearly typical of *sericatus* but approaches *monoensis* in greater mastoidal and interorbital breadths and narrower rostrum.

The southernmost record for this race is that of a young male from Shaver Ranger Station, Fresno County. Its skull is inseparable from those of subadult male topotypes and the color is nearly identical with them. It shows practically no evidence of intergradation with *occultus*.

Specimens examined.—Total number 30, all from California: *Tuolumne Co.:* Twain Harte P. O., 4000 ft., 2; Tuolumne Meadows, 8600 ft., 1. *Mariposa Co.:* 3 mi. N. E. Coulterville, 3200 ft., 2; Merced Grove Big Trees, 5400 ft., 1; Yosemite Valley, 4000 ft., 22; Porcupine Flat, 8100 ft., 1. *Fresno Co.:* Shaver Ranger Station, 5300 ft., 1.

Scapanus latimanus monoensis Grinnell

Scapanus latimanus monoensis Grinnell, Univ. California Publ. Zool., vol. 17, pp. 423–424, April 25, 1918 (orig. desc.).

Type.—Adult, female, skin and skull; no. 25,834, Mus. Vert. Zool.; Taylor Ranch, 5300 ft. altitude, 2 miles south of Benton Station, Mono County, California; August 29, 1917; collected by H. G. White, orig. no. 1376.

Range.—East base of the Sierra Nevada in Mono County, California, and along larger

streams draining eastward into Nevada from the vicinity of Yerington, Nevada, south to Mammoth, California (Howell, 1924, p. 27), and in Mono County east to the vicinity of Benton Station. Altitudinally from 4500 feet (10.5 miles south of Yerington) to 8000 feet (Mammoth). Life-zones, Upper Sonoran and Transition.

Diagnosis.—Size: Small (see measurements). Color: Pale, light grayish brown. Skull: Small, with long slender rostrum; moderately broad palate; broad interorbital region with slight interorbital constriction; short orbits and 'weak' zygomata; somewhat inflated braincase, moderately broad and rounded posteriorly with weakly developed supraoccipital ridge.

Color.—In worn summer pelage, from near Prout's Brown above and Hair Brown to Mouse Gray below in darkest individuals, to Saccardo's Umber above and Drab below in palest. Average color nearest the latter, some tending toward Buffy Brown above.

Comparisons.—Compared with *grinnelli, monoensis* is much paler and browner, the skull is generally narrower throughout, and males are larger. For more complete comparison see account of *grinnelli.*

From *sericatus, monoensis* is easily distinguishable by paler coloration, smaller size of body and skull, and shape of skull. The skull of *monoensis* is relatively broader, except in the rostral region, where they are about equal; rostrum also relatively shorter and more tapering; actual breadth of maxillary and interorbital regions about equal, but relatively greater in *monoensis;* interorbital region less constricted; zygomatic arches more nearly parallel; braincase relatively broader, deeper, and more sharply angled at mastoidal region; posterior part of braincase more rounded (less pointed posteriorly) in *monoensis,* with supraoccipital ridge less well developed.

Compared with *dilatus, monoensis* is much smaller but resembles that subspecies in color and in some skull characters. The skull differs from that of *dilatus* in being shorter and more robust, with rostrum relatively shorter and having less flare at anterior end; maxillary region relatively broader with sharper bend in upper tooth-rows; the bar lateral to the infraorbital foramen longer, more slender, and less nearly vertical; interorbital breadth about equal, but with less interorbital constriction; braincase comparatively broader and more flattened, with supraoccipital ridge less developed. Viewed from behind, the foramen magnum is higher in *monoensis.* Viewed from below, the pterygoid processes are shorter and blunter and the interpterygoid space is broader.

Remarks.—The male from Farrington's is slightly darker colored, and has a smaller skull with a more marked interorbital constriction and deeper, more inflated braincase. Possibly these features result from intergradation with *sericatus.* Indications of intergradation with that subspecies are furnished by two specimens of *sericatus,* a male from Porcupine Flat, and a female from Tuolumne Meadows, that have broader skulls than typical *sericatus.*

Moles of the subspecies *monoensis* follow some of the rivers into Nevada as indicated by 3 specimens taken 2 miles northwest of Morgans Ranch on the East Walker River, that are nearly typical *monoensis* but differ in the same way as the specimen from near Williams Butte, and in addition have broader rostra. This is also the case in one male from 10.5 miles south of Yerington, that is larger than typical *monoensis* and has the skull broader in every measurement. The size of this skull is about as in *grinnelli,* but the general shape is the same as those from the East Walker River. Larger size may indicate intergradation with *dilatus,* although proportions of the skull are quite unlike those of the latter race. The specimen is tentatively referred to *monoensis,* with realization of the possibility that it belongs to an unrecognized subspecies.

Specimens examined.—Total number 16. **Nevada:** *Lyon Co.:* 10.5 mi. S. Yerington, 4500 ft., West Walker River, 1. *Mineral Co.:* East Walker River, 5050 ft., 2 mi. N. W. Morgans Ranch, 3. **California:** *Mono Co.:* Farrington's (near Williams Butte), 6800 ft., Mono Lake, 1; Pellisier Ranch, 5 mi. N. Benton Station, 5600 ft., 1 (San Diego Soc.

Nat. Hist.); Taylor Ranch, 5200–5300 ft., 2 mi. S. Benton Station, 10 (2 San Diego Soc. Nat. Hist., 2 Dickey coll.).

Scapanus latimanus grinnelli Jackson

Scapanus latimanus latimanus, Grinnell, Proc. California Acad. Sci., vol. 3, p. 269, 1913 (part).

Scapanus latimanus grinnelli Jackson, Proc. Biol. Soc. Washington, vol. 27, p. 56, March 20, 1914 (orig. desc.).

Type.—Adult, male, skin and skull; no. 17,785, Mus. Vert. Zool.; site of old Fort Independence (on ranch of Carl Walters), 2 miles north of Independence, 3900 ft. altitude, Inyo County, California; collected by H. A. Carr, May 8, 1912; orig. no. 915.

Range.—Southern end of Sierra Nevada south probably from Olancha Peak, and in Owens Valley probably from Bishop south to Little Lake. Altitudinal range from 3700 feet (at Lone Pine, Inyo County) to 6700 feet (at Upper Funston Meadow, Kern River, Tulare County). Zonal range, Lower Sonoran to high Transition.

Diagnosis.—Size: Small (see measurements). Color: Darkest of the small subspecies of the *latimanus* group, near Fuscous Black in fresh summer pelage. Skull: Short and broad; rostrum short and broad (rostral breadth averaging 13.2 per cent of greatest length of skull); palate broad; interorbital region broad (interorbital breadth more than 23.7 per cent of greatest length of skull), arched dorsally, and with no interorbital constriction; braincase broad (mastoidal breadth averaging more than 50.7 per cent of greatest length of skull), not inflated but sharply angled at the mastoidal region, and rather truncate posteriorly; part of foramen magnum visible when skull is viewed from directly above.

Color.—In worn winter pelage, near Fuscous Black above; Hair Brown to Deep Mouse Gray below; one specimen stained on throat and chest with Dresden Brown. In fresh summer pelage, Mummy Brown to Fuscous above; Drab to Chaetura Drab or Deep Mouse Gray below, some with slight tinge of Dresden Brown on chin and midventral line.

Comparisons.—Compared with *occultus*, *grinnelli* is larger and darker, although specimens from the southern Sierra Nevada and Porterville approach it in color. The skull of *grinnelli* is larger, much broader, and more heavily built, lacking interorbital constriction characteristic of *occultus* and with dorsal outline of skull an unbroken continuous curve; zygomatic arches heavier, with external side of posterior base turned inward toward braincase rather than directed straight back; braincase slightly higher, broader, and more sharply angled at mastoidal region; supraoccipital ridge not overhanging foramen magnum as far as in *occultus*, and foramen magnum higher, so as to be partly visible when skull is viewed from directly above; basioccipital region more depressed to form a deeper groove, and interpterygoid space wider.

In comparison with *monoensis*, males of *grinnelli* are smaller in external measurements; females of about same size; color much darker; skulls of about same length or slightly shorter than in *monoensis* but with shorter rostrum; relatively longer palate; relatively broader maxillary region; broader interorbital region, with no interorbital constriction; broader, more flattened, and more truncate braincase.

This subspecies can be distinguished from *sericatus* by its darker color, smaller size, and actually broader skull. For more complete comparison see account for *sericatus* and Table I.

Remarks.—Moles from Upper Funston Meadow, Tulare County, and Lone Pine, Inyo County, are not typical *grinnelli* but show some characters of *occultus* in the skull. These characters and the generally paler color, indicate intergradation with *occultus*. Seven specimens from the Walker Basin, Kern County, are referred to *occultus* on color and characters of the interorbital and mastoidal regions of the skull, but are intermediate between *occultus* and *grinnelli* for mastoidal, maxillary, and rostral breadths, and length

of the maxillary tooth-row. All these specimens clearly show intergradation between the two subspecies.

Intergradation has not been found between *grinnelli* and any subspecies other than *occultus*, but in view of the similarity between *grinnelli* and *monoensis*, intergradation would be expected to take place in the upper end of the Owens Valley if their ranges meet in that area.

Specimens examined.—Total number 11, all from California: *Tulare Co.*: Upper Funston Meadow, 6700 ft., Kern River, 1 (Joseph Dixon Coll. at Mus. Vert. Zool.); *Inyo Co.*: Site of old Fort Independence (on ranch of Carl Walters), 2 mi. N. Independence, 3900 ft., 7; Lone Pine, 3 (2 Dickey).

Scapanus latimanus occultus Grinnell and Swarth

Scapanus anthonyi, Allen, Bull. Amer. Mus. Nat. Hist., vol. 5, p. 200, 1893 (part).

Scapanus californicus, True, Proc. U. S. Nat. Mus., vol. 19, p. 52, 1896 (part).

Scapanus californicus anthonyi, Stephens, California Mammals, San Diego, p. 257, 1906 (part).

Scapanus latimanus, Grinnell, Univ. California Publ. Zool., vol. 5, pp. 157–158, 1908 (part).

Scapanus latimanus occultus Grinnell and Swarth, Univ. California Publ. Zool., vol. 10, p. 131, April 13, 1912 (orig. desc.).

Type.—Subadult, female, skin and skull; no. 2369, Mus. Vert. Zool.; Santa Ana Canyon, 400 ft. altitude [12 miles northeast of Santa Ana], Orange County, California; September 20, 1908; collected by H. S. Swarth, orig. no. 7051.

Range.—Chiefly southern California. From near Porterville, Tulare County and Kings River Canyon, Fresno County, south in the Sierra Nevada west of the Kern River drainage, and through the Tehachapi Mountains (west at least to Santa Barbara), thence south, west of the desert divides, to the Mexican boundary, and in Lower California, Mexico, probably in favorable places throughout the Sierra Juarez. Ranges altitudinally from near sea level (Ventura) to 9800 feet (Twin Lakes, Sequoia National Park, Tulare County). Zonal range, from Lower Sonoran to Canadian.

Diagnosis.—Size: Small (see measurements). Color: Generally pale and brownish. Skull: Smaller, with relatively narrow, tapering rostrum; relatively broad interorbital region; small narrow orbits; relatively broad, deep braincase.

Color.—As observed in specimens from the vicinity of Los Angeles: In fresh winter pelage, near Fuscous above; slightly lighter below. In worn winter pelage, between Benzo Brown and Drab or near Saccardo's Umber above; Hair Brown below. In fresh summer pelage, Drab above; near Mouse Gray below. In worn summer pelage, between Buffy Brown and Olive Brown above; near Drab below.

Specimens in worn summer pelage from Walker Basin, Kern County, are paler and more brassy, palest Buckthorn Brown to Dresden Brown above; Buffy Brown below; darkest Saccardo's Umber toward Sepia above.

Comparisons.—Compared with *anthonyi* from Sierra San Pedro Martir, Lower California, Mexico, *occultus* is slightly larger and paler colored, with skull larger, relatively narrower, and less flattened; relatively narrower and shorter rostrum; usually with the normal number of 44 teeth. A more complete comparison will be found in *Comparisons* for *anthonyi*.

Compared with *grinnelli*, *occultus* is lighter colored, slightly smaller and has a narrower skull with longer rostrum, a distinct interorbital constriction, and less angular mastoidal region. For further comparison see account for *grinnelli*.

Compared with *campi*, *occultus* is smaller, with no overlapping in actual measurements of skull, although there is some overlap in body measurements; color darker, especially

in winter pelage; shape and proportions of skull much the same, but with certain differences sufficient to distinguish the two as given in *Comparisons* for *campi*.

From *sericatus*, typical *occultus* can be distinguished by smaller size; lighter, more brownish color; smaller and broader skull with narrower and shorter rostrum. The other width measurements are all comparatively greater. The braincase of *occultus* is much less angular (more rounded) in old adults and somewhat more flattened, with less well developed supraoccipital ridge.

For comparison with *latimanus*, see the account of that race.

Remarks.—S. l. occultus is a well defined subspecies that displays surprisingly little variation over a large range. Specimens from south of 36 degrees N. latitude are all very much alike, although moles from San Diego County are smaller and have slightly broader and more flattened skulls, in these characters probably approaching those of *anthonyi*. Intergradation, in the sense of actual meeting of ranges, is not known to take place between these two forms. The southernmost record is one from Laguna Hanson, Sierra Juarez, Lower California, Mexico (San Diego Soc. Nat. Hist.). It is nearly typical *occultus* in all characters except for the reduced length of skull, which is even less than in one specimen of *anthonyi*.

Specimens from Walker Basin, Kern County, approach *grinnelli* in large size, relatively greater mastoidal, maxillary, and rostral breadths, and length of maxillary toothrow. They are nearly typical of *occultus* in color and characters of the interorbital and mastoidal regions of the skull. Intergradation takes place also around the southern end of the Sierra Nevada from Lone Pine, Inyo County, to Upper Funston Meadow, 6700 feet altitude, Kern River, Tulare County. Moles from this area are nearly typical of *grinnelli* but approach *occultus* in a few characters of the skull and in paler color.

Specimens from north of 36 degrees N. latitude differ somewhat from typical *occultus* in having slightly darker color and narrower skulls. Although these differences are constant, it appears that they are not great enough to warrant recognition of a separate subspecies there. The above mentioned characters may indicate approach toward *sericatus*.

The northernmost series of *occultus*, from Kings River Canyon, shows intergradation with *campi* as discussed in the account of that race.

Intergradation with *latimanus* is indicated by specimens referred to that race from Santa Margarita, and from San Benito County, as set forth in the account of *latimanus*. Specimens of *occultus* from Santa Barbara County, and from Ojai Valley, are larger than typical *occultus* in external measurements, and in skull measurements approach in size *latimanus* from the southern part of its range; proportions (shape) of the skulls, however, are as in *occultus*.

Specimens examined.—Total number 136, as follows: **California:** *Fresno Co.:* Kings River Canyon, 5000 ft., 7; Hume, 5300 ft., 1. *Tulare Co.:* Big Meadow, 7660 ft., 1[4]; Twin Lakes, 9800 ft., Sequoia National Park, 2; 4 mi. N. E. Springville, 2800 ft., 1[4]; 6 mi. W. N. W. Porterville, 380 ft., 4[4]; Porterville, 450 ft., 1[4]; 4 mi. S. E. Porterville, 550 ft., 6 (4[4]); Parker Meadow, 6400 ft., 3[4]. *Kern Co.:* S. W. part Walker Basin, 3300–3350 ft., 7. *Santa Barbara Co.:* Santa Barbara, 3[5]; Montecito, 1[5]. *Ventura Co.:* Sespe, 1; Ventura, 1; Ojai Valley, 1200–1250 ft., 17[5]. *Los Angeles Co.:* Los Angeles, 22 (4[6], 15[7]); Pasadena, 8 (1[6], 3[5]); Sierra Madre, 1; San Gabriel, 1[8]; Covina, 10[5]; Whittier, 1; Gardena, 2[6]; Pomona, 1[9]. *San Bernardino Co.:* Bear Flat, San Gabriel Mountains, 6400

[4] W. B. Richardson.
[5] D. R. Dickey.
[6] J. C. von Bloeker, Jr.
[7] Los Angeles Museum.
[8] Calif. Acad. Sci.
[9] San Diego Soc. Nat. Hist.

ft., 2; Camp Baldy, 2[7]; Lytle Creek, 3000 ft., 1[9]; San Bernardino, 1[9]. *Orange Co.*: Santa Ana Canyon, 400 ft., 1; Tustin, 100 ft., 1. *Riverside Co.*: Strawberry Valley, 6000 ft., San Jacinto Mountains, 1; Thomas Mountain, 6800 ft., San Jacinto Mountains, 1. *San Diego Co.*: Warner Pass, 1; Escondido, 4 (1[10], 1[9]); Ramona, 9[9]; Ballena, 1[9]; Witch Creek, 2 (1[9]); Santa Ysabel, 1[9]; Julian (and 1 mi. E.), 3 (1[9]); Lakeside, 1[9]; Alpine, 1[9]. **Lower California, Mexico**: Laguna Hanson, Sierra Juarez, 1[9].

Scapanus latimanus anthonyi Allen

Scapanus anthonyi Allen, Bull. Amer. Mus. Nat. Hist., vol. 5, p. 200, 1893.

Type.—Adult male, skin and skull; number $\frac{6313}{4947}$, Amer. Mus. Nat. Hist.; San Pedro Martir Mountains (7000 feet altitude), Lower California, Mexico; collected by A. W. Anthony, May 8, 1893. (*Fide* Allen, 1893, p. 200.)

Range.—Known only from the Sierra San Pedro Martir, Lower California, Mexico. From Vallecitos south to La Grulla. Altitudinal range from 7000 feet (type locality) to 7500 feet (at Vallecitos). Zonal range, Transition.

Diagnosis.—Size: Smallest of the genus (total length averaging less than 145 mm.). Color: Dark, in worn summer pelage. Skull: Smallest for the species (greatest length less than 31.9 mm.), relatively broad throughout, and generally flattened; rostrum short; teeth large and crowded; premolars in all known specimens reduced in number to at most $\frac{3}{3}$ (in 4 specimens $\frac{2}{2}$).

Color.—In worn summer pelage, upper parts between Mummy Brown and Fuscous Black, underparts Drab to Fuscous.

Comparisons.—From *occultus*, its near neighbor to the north, *anthonyi* differs only slightly. Body measurements are smaller, and the color of the two subspecies is very similar, with *anthonyi* averaging slightly darker. Skulls in general, similar but smaller in *anthonyi* with relatively broader, shorter rostrum; broader maxillary and interorbital regions; relatively broader, more flattened braincase; teeth larger and more crowded; premolars reduced in number.

Remarks.—The close relationship of *anthonyi* to *occultus* is clearly evident. The size difference is not marked, especially in specimens of *occultus* from San Diego County, as has been already pointed out by Huey (1936, p. 166). The color difference is also slight. Skulls of *occultus* from the southern part of the range are as small as some skulls of *anthonyi*, but the ratios of breadth measurements to greatest length are only slightly greater than in typical *occultus*. Furthermore, reduction in number of teeth is fairly common in *occultus*. For example, in a series of 7 males examined from Los Angeles County, one has the same tooth formula as the type of *anthonyi*, one has only 3 premolars in each maxillary tooth-row, and one has but 3 premolars in the right maxillary tooth-row.

Not only does *occultus* approach *anthonyi* in reduction of number of teeth, but the number of teeth is not constant in *anthonyi*. Numbers 36,007 and 37,617 (Mus. Vert. Zool.) from La Grulla, and 11,406 and 11,407 (San Diego Soc. Nat. Hist.) from La Encantada, have one less premolar than the type in each maxillary tooth-row. Number 36,009 (Mus. Vert. Zool.) has P^2 rudimentary. All known specimens agree, however, in having premolars reduced to $\frac{2}{2}$ at most.

Although actual meeting of the ranges of *occultus* and *anthonyi* may not occur, I have regarded both as subspecies of *latimanus* because they overlap in their characters.

Certain characters ascribed to *anthonyi* have not been found to hold for specimens

[10] Coll. Ralph Ellis.

examined in this study. Jackson (1915, p. 76) stated that, "... each of the parietals of *occultus* has a small posterior projection, extending between the interparietals and the mastoid which is not present on the parietals of the type of *anthonyi*." This character has not been found in any of the specimens examined in this study. Huey (*loc. cit.*) in writing of the 2 specimens from La Encantada, stated that, "... The manus of *anthonyi*, although smaller than that of *occultus* is proportionately squarer, with broader and heavier phalanges that are armed with wider, heavier nails." My examination of the feet of dried specimens fails to show any marked difference in this respect between *anthonyi* and *occultus*. Huey, however, had the opportunity of examining the moles in the flesh and it is possible that squareness of palm then was more evident. The "wider, heavier nails" are not evident in specimens examined in this study. Actually, they are about equal in the two subspecies. Huey also observed that the pterygoids of *anthonyi* remain parallel to the tips, while the pterygoids of *occultus* tend to approach one another at the tips. This character is shown only in Huey's 2 specimens from La Encantada and in one from La Grulla. The other 3 specimens examined, are inseparable from *occultus* on this character.

Specimens examined.—Total number 6, all from the Sierra San Pedro Martir, Lower California, Mexico: Vallecitos, 7500 ft., 1; La Encantada, [7400 ft.], 2 (San Diego Soc. Nat. Hist.); La Grulla, 7200 ft., 3.

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SKELETAL AND MUSCULAR DIFFERENCES IN THE HIND LIMBS OF LEPUS, SYLVILAGUS, AND OCHOTONA

By Charles L. Camp and Adrey E. Borell

Introduction.—The American jack-rabbits and pikas are related forms but differ widely in their manner of locomotion. The pikas progress in a series of short, quick hops, traveling in this way over and beneath the broken rock slides which they inhabit. Here the narrow, crooked passages restrict leaping movements. The rabbit-like claws of the pikas do not permit them to clamber over the surfaces of the rocks in the manner of the bushy-tailed wood rat, *Neotoma cinerea*, which occupies the same habitat. Jack-rabbits live primarily in the open and escape their enemies by fleetness and endurance. When traveling at high speed, they progress by a series of long, bounding leaps.

Intermediate in some respects between the jack-rabbits and the pikas are the cottontails (*Sylvilagus*), which live in and about brush patches and thickets. They depend upon quick, darting movements in their brush-covered runways. In speed and endurance, they stand between the jack-rabbits and the pikas. In their muscular and skeletal adaptations, as discussed in this paper, they also lie between the extremes of the jack-rabbits and pikas. Naturally, these adaptations are most pronounced in the hind limb—the chief means of propulsion. For this reason, the hind limb and girdle are chosen as the subjects of this study.

Acknowledgments.—The material used has been furnished largely by the Museum of Vertebrate Zoology, University of California. We are indebted to members of the staff of this Museum for assistance and advice, especially to Dr. E. R. Hall. Mr. Ralph Ellis of Berkeley has also loaned specimens from his private collection.

Material.—Specimens from which descriptions of muscles and skeleton were taken are as follows:

Jack-rabbit, *Lepus californicus californicus* Gray; adult ♀, no. 46,915, M.V.Z.; adult ♂, no. 2554, M.V.Z.; adult ♂, no. 34,998, M.V.Z. Skeletal measurements were taken from the last. Muscle descriptions are mainly from no. 46,915.

Cottontail, *Sylvilagus auduboni auduboni* (Baird); adult ♂, no. 46,916, M.V.Z.; adult ♀, no. 46,917, M.V.Z. Descriptions of muscles were taken mainly from the former.

Pika, *Ochotona princeps taylori* Grinnell; 15 specimens, nos. 36,900–36,915, M.V.Z.; also adult ♂, no. 11,293, M.V.Z., used for skeletal measurements. *Ochotona princeps schisticeps* (Merriam); 10 specimens, nos. 36,879–36,889, M.V.Z., and *Ochotona princeps albatus* Grinnell, no. 17,302, M.V.Z., were dissected for comparison.

The terminology is that used by the B.N.A. (Emmel, 1927), by Bensley (1926), and by Appleton (1928), except where terms have been changed to others seemingly more appropriate.

MUSCULAR DIFFERENCES IN RABBITS AND PIKAS

The most obvious muscular differences between the three genera studied are found in the relative lengths of the tendons of the limb muscles. These are longer in *Lepus* than in *Sylvilagus*, and the majority of the muscles of *Ochotona* are without tendons or with short ones only. As in deer, horses and other swift cursorial mammals, the limb muscles of *Lepus* are bunched near their origins and taper quickly into the long, thin tendons by which they insert. The same muscles in *Ochotona*, on the other hand, often have fleshy insertions, the muscles maintain more uniform thickness throughout, and the insertions are almost as wide as the origins. Compare for instance the gracilis muscles illustrated in figures 1 and 2.

TABLE 1

TENDONS OF INSERTIONS VS. TOTAL LENGTH OF MUSCLE + TENDON

MUSCLE	LEPUS	SYLVILAGUS	OCHOTONA
Sartorius	35%	31%	none
Semitendinosus	32%	32%	11%
Semimenbranosus	21%	17%	none
Tenuissimus	25%	23%	none
Gracilis	30%	29%	none
Tibialis anterior	48%	40%	37%
Gastrocnemius	46%	41%	30%
Soleus	38%	37%	25%

An attempt to measure the percentage of tendon in various muscles of the hind limb is given in table 1. The percentages given indicate the length of the distal tendinous portion in respect to the total length of the muscle. Tendons of the lower leg muscles were measured only as far as the distal end of the tibia.

Muscles such as many of those in *Lepus*, which are fleshy near their origins and are inserted by long tendons, have the advantage of giving greater lightness and speed of movement to the limbs. The fleshy portion is also brought relatively nearer the main blood and nerve supplies. Insertion by a small tendon, rather than by a large muscle, also renders possible a greater concentration of force upon the bone, and improves the leverage and precision of action.

Since muscle is composed of fibers, each of which has a contraction limit and rate, the amount of contraction is largely proportional to the length of the fleshy portion of the muscle. Thus, when a large part of the length of a

hind leg muscle of *Lepus* is given over to tendon, the amount of contractibility is decreased. A greater extent of movement of the limb, however, may be provided by decreasing the angle of pull.

The muscles of *Lepus* are considerably more differentiated than are those of *Ochotona*. In the latter, some of the important muscles are fused or have never been differentiated, whereas in *Lepus* these muscles are split up and are able to function individually. This is especially true of the two portions of the biceps femoris and the semimembranosus (figs. 3, 4).

This differentiation of muscles undoubtedly results in, or is because of, a greater range of movement of the parts concerned and it might therefore be expected in such a highly specialized running form as *Lepus*. *Sylvilagus* occupies an intermediate place, but is decidedly nearer to *Lepus* than to *Ochotona*.

In freshly killed specimens of *Lepus* the muscles of the hind limbs are of a dark red color, whereas those in the same region in *Sylvilagus* and *Ochotona* are pale. Zoethout (1928, pp. 86–87) summarized the physiological differences between the action of light and dark muscles. He stated that the pale muscles "are more excitable, quicker in their action, but fatigue more rapidly . . . the height of contraction and the time during which contraction can be maintained are greater for the red than the pale muscle." Howell (1930) was inclined to be more non-committal and observed that "rapidly contracting fibers may occur which are red or granular or both." Perusal of references cited by Howell indicates that there are many unsettled questions regarding the physiology of dark and pale muscles. The statements of Zoethout are largely substantiated by experimental work.

In the jack-rabbit the muscle attachments are designed for speed and the muscles for endurance. In the cottontail and pika, the muscles probably support more rapid action and lesser endurance, and the muscle attachments are not designed for speed.

SKELETAL DIFFERENCES IN THE HIND LIMBS

Some differences in the pelvic girdles of *Lepus*, *Sylvilagus* and *Ochotona* are as follows: In *Lepus* the innominate bones are strongly and completely fused along the pubic symphysis, which is about 23 mm. long. In *Ochotona* the two halves of the pelvic girdle are not fused and the short inferior rami of the ischium and pubis are joined by a thick ligament. *Sylvilagus* is similar to *Lepus* in this respect. The fusion of the two halves of the pelvic girdle, as in *Lepus*, produces a stronger and more rigid girdle than the type found in *Ochotona*, and increases the support of the longer limbs and heavier muscles of *Lepus*.

In *Ochotona* the innominate bone is longer than the femur, while in *Lepus* the femur is proportionately 33.6 per cent longer than in *Ochotona*, as is shown in table 2.

These skeletal proportions are reflected in the angle of pull of the muscles, which in turn affects the rate of movement of the limb. The tensor fasciae latae and rectus femoris anterior, which originate on the anterior border of the ilium and insert on the patella, pull at a much sharper angle in *Lepus* than in *Ochotona* (figs. 5, 6). This gives *Lepus* greater speed than *Ochotona* in flexing the femur, since the speed at which the distal end of the bone moves is inversely proportional to the angle of insertion of the acting muscle (Gregory, 1912, pp. 278–279). In this connection it should be noted (table 3 and fig. 6) that in *Ochotona* the acetabulum is proportionately nearer the posterior end of the innominate bone than it is in *Lepus*. The muscles that originate on the posterior portion of the innominate bone therefore pull at about the same angle in both species.

TABLE 2

RELATIVE LENGTHS OF FEMUR AND INNOMINATE BONES

	LEPUS	OCHOTONA
Length of innominate bone	87 mm.	29.2 mm.
Length of femur	122 mm.	28.5 mm.
Ratio of innominate to femur	71.3%	105.9%

TABLE 3

RELATIVE LENGTH OF ILIUM AND INNOMINATE BONE

	LEPUS	OCHOTONA
Length of ilium	43.4 mm.	17.5 mm.
Length of innominate bone	87.3 mm.	30.3 mm.
Ratio of ilium to innominate	49.7%	57.7%

In *Ochotona* the portion of the innominate bone that is anterior to the acetabulum is 8 per cent longer than in *Lepus*.

Another factor to be considered is the length of the part of the movable bone that extends beyond the point of insertion of the contracting muscle. That is, if two muscles attach to the movable bone at the same distance and pull at the same angle, they will cause the distal end of the bone to move through the same length of arc providing the bones be of the same length. But if the bones be of unequal length, then the distal end of the longer bone will move through the longer arc and thus produce greater movement or speed in the same length of time. This, however, is done with loss of power, since the load at the distal end of the long bone is farther from the fulcrum. Reference to the descriptions of individual muscles shows that several important muscles of the thigh and hip insert upon the proximal end of the tibia. As is shown in table 4, the hind foot and tibia of *Lepus* is propor-

tionately longer, when compared with the femur, than in *Ochotona*. This construction and the principles involved are therefore such as to give greater speed to the portion of the hind foot of *Lepus* that comes into contact with the ground when leaping.

Table 4 shows that in *Lepus* the hind foot is 50.9 per cent of the length of the tibia and femur combined, whereas in *Ochotona* the hind foot is only 40.7 per cent of this length. Thus, when the lengths of the elements of the hind limbs of *Lepus* and *Ochotona* are compared, it is found that in *Lepus* the tibia is proportionately longer than the femur, and the hind foot is proportionately longer than the combined lengths of tibia and femur.

When the length of the femur is compared with the length of the tibia it is found that in *Lepus* the femur is 83.4 per cent of the length of the tibia,

TABLE 4

LENGTH OF HIND FOOT RELATIVE TO TIBIA AND FEMUR

	LEPUS	OCHOTONA
Combined length of tibia and femur	261 mm.	61.3 mm.
Length of hind foot	133 mm.	25 mm.
Ratio of hind foot to combined length of tibia and femur	50.9%	40.7%

TABLE 5

RELATIVE LENGTH OF FEMUR AND TIBIA

	LEPUS	OCHOTONA
Length of femur	116 mm.	29.4 mm.
Length of tibia	139 mm.	32.8 mm.
Ratio of femur to tibia	83.4%	89.6%

whereas in *Ochotona* the femur is 89.6 per cent of the tibia (table 5). This means that in *Lepus* the femur is proportionately 6.2 per cent shorter.

One of the adaptations of cursorial animals is the elongation of the distal bones of the limbs. In this respect the difference between *Lepus* and *Ochotona* corresponds with the difference in the modes of locomotion of the two forms.

MUSCLES OF THE UPPER LEG

In the following descriptions the differentiated muscles of *Lepus* are sometimes spoken of as "fused" in *Ochotona*. Another obvious interpretation would be that the "fused" muscles of *Ochotona* represent a primitive, undifferentiated condition.

Gluteus maximus. Origin: First portion, by fascia from spinous processes

of posterior three sacral and the first caudal vertebrae. Second portion, fleshy from ventral border of iliac wing and by fascia covering gluteus medius. Insertion: First portion, by flat tendon on third trochanter of femur; second portion, fleshy on third trochanter of femur. The two portions are united by aponeurosis. In *Lepus* and *Sylvilagus* the anterior portion is fused with the posterior border of tensor fasciae latae and the first head of rectus femoris, but the line of fusion is obvious. In *Ochotona* the fusion of these muscles is complete.

Gluteus medius. Origin: *Lepus*, fleshy from anterior superior and inferior borders of iliac wing and by fascia covering lateral processes of first two sacral vertebrae. *Sylvilagus*, same. *Ochotona*, fleshy from iliac spine and anterior superior border of iliac wing and fleshy from the three proximal sacral vertebrae. Insertion: By very short tendon on greater trochanter of femur, and fleshy to superior border of trochanteric fossa.

Gluteus minimus. Origin: Fleshy from entire lateral surface of the body and wing of ilium. Insertion: By short tendon on greater trochanter of femur. In *Ochotona* this muscle is fused along its posterior border with the piriformis, also slightly fused with gluteus medius along its inferior lateral border. In *Lepus* and *Sylvilagus* these three muscles can usually be separated.

Tensor fasciae latae (Rectus femoris anterior of Bensley). Origin: Fleshy from anterior and anteroventral border of iliac wing and by fascia covering gluteus medius; same in all three genera. Insertion: By broad tendon on superior border of patella, and by broad fascia covering the lateral surface of thigh. This muscle is fused with the ventral border of the anterior portion of the gluteus maximus. The fusion is not as marked in *Lepus* and *Sylvilagus* as in *Ochotona*.

Piriformis. Origin: Fleshy from lateral portions of second and third sacral vertebrae. Insertion: By short tendon on posterior superior border of greater trochanter of femur. In *Ochotona* this muscle is fused with the posterior border of gluteus minimus.

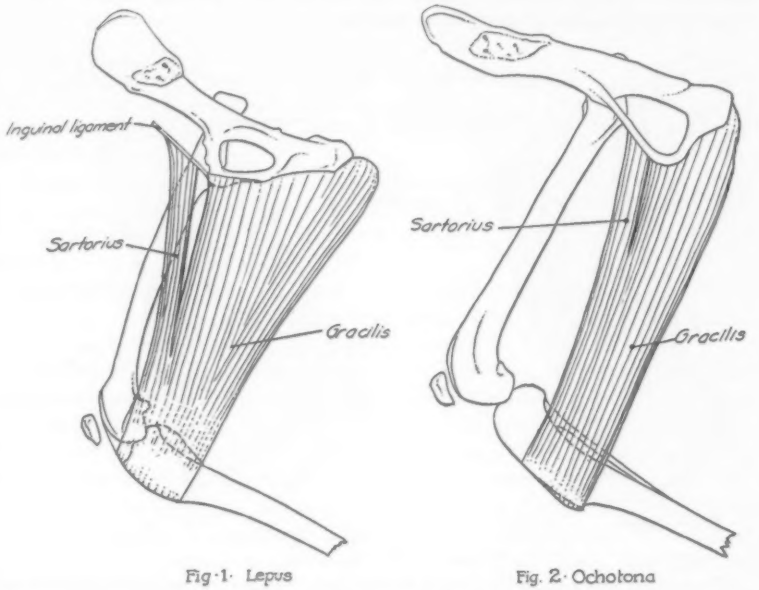
Pectineus. Origin: Fleshy from pecten and medial portion of ramus of pubis. Insertion: By short flat tendon on medial border of femur, just below trochanter minor. In *Ochotona* this muscle is relatively thinner, less bunched, has relatively broader origin and insertion, and overlies a larger portion of the adductor brevis than it does in the other two lagomorphs.

Biceps femoris anterior (Femorococcygeus). Origin: *Lepus* and *Sylvilagus*, fleshy from spinous processes of the four posterior sacral and the two anterior caudal vertebrae. Insertion: By long flat tendon on lateral margin of patella. This muscle is the femorococcygeus element of authors.

Biceps femoris posterior. Origin: *Lepus* and *Sylvilagus*, fleshy from ischial tuberosity and lateral process of ischial tuberosity. On the under surface of this muscle is a small portion that originates from the lateral

process of the ischial tuberosity by a short flat tendon. Insertion: *Lepus* and *Sylvilagus*, by broad fascia on lateral border of patella and proximal third of lateral surface of lower leg.

Biceps femoris anterior et posterior. Origin: *Ochotona*, fleshy from spinous processes of posterior sacral and three proximal caudal vertebrae and ischial tuberosity. On the under surface of this muscle is a small tendinous portion that originates as it does in *Lepus*. Insertion: *Ochotona*, by short fascia on lateral border of patella and lateral surface of proximal third of



Fig·1· Lepus Fig. 2· Ochotona

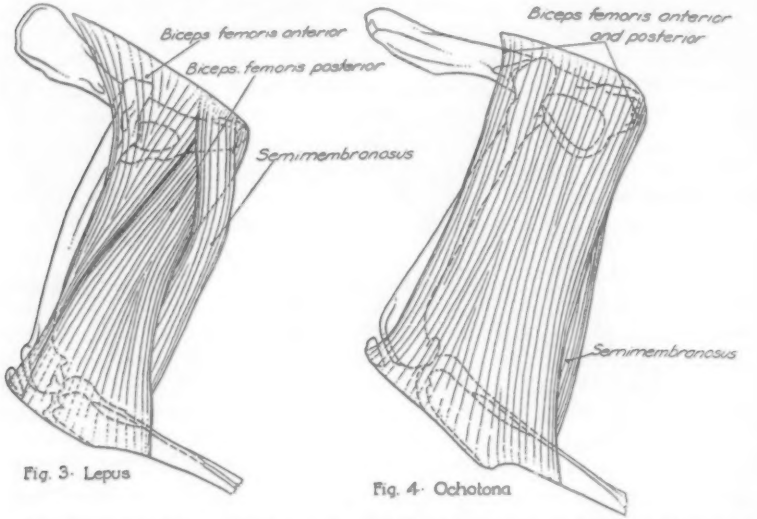
FIGS. 1 AND 2. Sartorius and gracilis, showing the degree of fleshiness of the two muscles in *Lepus* and *Ochotona*.

lower leg. In *Ochotona* this muscle is relatively narrower at its origin than it is in *Lepus*. Only a small portion of its fibers cover the posterior portion of the gluteus maximus. The posterior portion is fused near its head with the head of the semimembranosus. The two portions of the biceps were completely fused in all specimens of *Ochotona* examined.

Sartorius. Origin: *Lepus*, fleshy from medial portion of inguinal ligament. *Sylvilagus*, same. *Ochotona*, fleshy from anterior border of pubis. Insertion: *Lepus*, by long fascia on proximal medial border of tibial tuberosity. *Sylvilagus*, same, but fascia of insertion relatively shorter. *Ochotona*, fleshy, on the proximal medial border of tibial tuberosity. In all three forms this

is a long slender ribbon-like muscle. In *Lepus* it is only slightly fused with the gracilis near the distal end of the fleshy portion. In *Sylvilagus* this fusion is more pronounced. In some specimens of *Ochotona* the sartorius is fused for most of its length with the gracilis; but in others it is distinct through its proximal half.

Rectus femoris posterior. Origin: Fleshy from inferior anterior spine of ilium, immediately anterior to acetabulum. Insertion: By short heavy tendon on superior border of patella. A stout muscle with much fascia in and over its distal third. Very similar in the three genera, but in *Ochotona* it is thicker relative to the vastus lateralis.



FIGS. 3 AND 4. In *Lepus* the two portions of the biceps femoris and semimembranosus are separate muscles, while in *Ochotona* all three are fused except for the lower portion of semimembranosus, which is separate.

Vastus lateralis. Origin: By short broad tendon from anterior and lateral borders of greater trochanter. Insertion: *Lepus*, by short tendon on superior border of patella. *Sylvilagus*, same. *Ochotona*, fleshy, on patella. In *Lepus* and *Sylvilagus* this muscle is not fused with any other, but in *Ochotona* it is solidly fused with the two deeper portions of the vastus.

Vastus medialis. Origin: Fleshy from the central portion of greater trochanter and from anterior and medial surfaces of proximal third of femur. Insertion: Fleshy, on superior median border of patella and by fascia on patellar ligament. In *Sylvilagus* and *Ochotona* this muscle is slightly fused with the deeper portions of the vastus intermedius.

Vastus intermedius. Origin: Fleshy, in two portions, from anterior surface of greater and third trochanters and from anterolateral and medial surfaces of shaft of femur. In *Lepus* and *Sylvilagus* the two portions of this muscle can be separated. In *Ochotona* they are fused and the two are also fused with the vastus lateralis.

Gemelli. Origin: Fleshy from entire medial surface of inferior ramus of ischium, the ischial tuberosity, and the lateral border of the superior ramus of the ischium. Insertion: Tendinous, to trochanteric fossa. The fibers of these muscles fold over the superior ramus of the ischium and the fibers of the two portions are fused. The tendon of the obturator internus is partially buried in the external surface of the gemelli.

Obturator internus. Origin: Fleshy from internal superior, anterior, and ventral borders of obturator foramen. Insertion: By heavy tendon which passes over ischium just posterior to ischial spine to its insertion in the trochanteric fossa.

Quadratus femoris. Origin: Fleshy from antero-ventral border of ischial tuberosity. Insertion: Fleshy and tendinous, on third trochanter and shaft of femur just beneath the trochanteric fossa. Slightly fused with the gemelli.

Semitendinosus. Origin: Fleshy from posterior ventral border of ischial tuberosity. Insertion: *Lepus*, by long tendon on medial condyle of tibia. *Sylvilagus*, same. *Ochotona*, by short tendon on medial condyle.

Semimembranosus. Origin: *Lepus* and *Sylvilagus*, in two portions, first by a broad thin section that originates from fascia covering head of biceps femoris; second portion, by short flat tendon from ischial tuberosity; in *Ochotona* the same, except that first portion is entirely fleshy and is completely fused with head of biceps femoris posterior. Insertion: *Lepus* and *Sylvilagus*, in common with gracilis, by broad fascia covering proximal third of medial surface of lower leg. This fascia is contracted into two tendons, one of which inserts upon the distal end of the tibial crest. The other extends distad along the medial surface of the lower leg, where it fuses with the tendons of the soleus and is then inserted on the calcaneus. In *Ochotona*, fleshy, on the tibial crest.

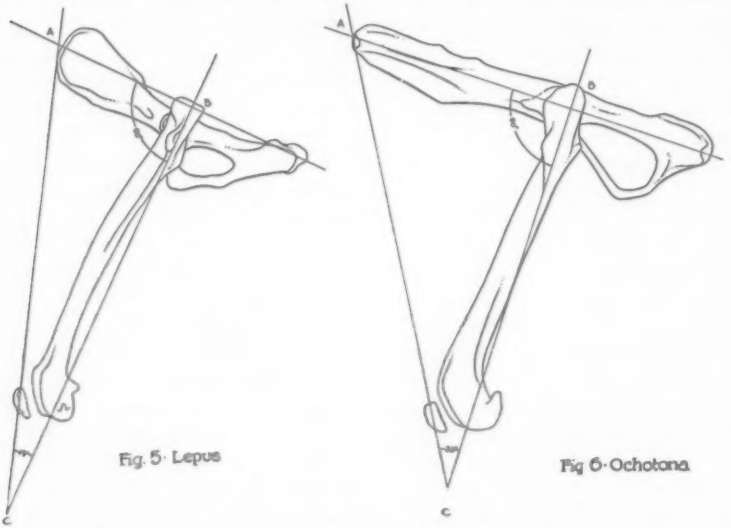
Tenuissimus (Tensor fasciae cruris). Origin: By long slender tendon from transverse process of fourth sacral vertebra. Insertion: By fascia in common with posterior border of biceps femoris on lateral surface of lower leg just below tibial crest. A long ribbon-like muscle, in *Ochotona*, fused near its head with the posterior median border of biceps anterior.

Obturator externus. Origin: Fleshy from entire external margin of obturator foramen. Insertion: By short heavy tendon to trochanteric fossa.

Adductores longus et magnus (of Bensley). Origin: Fleshy from ischial tuberosity and lateral process of same, also from ramus of ischium and pubic symphysis. Insertion: Fleshy, on posterior surface of shaft of femur and medial condyle of tibia. These two muscles are fused in all three genera.

Adductor brevis (of Bensley). Origin: Fleshy from anterior portion of pubic symphysis and lower portion of ramus of pubis. Insertion: By short broad tendon on posterior surface of proximal portion of shaft of femur.

Gracilis. Origin: *Lepus*, partly fleshy and partly tendinous, from anterior border of pubic symphysis to lower tip of ischial tuberosity; fascia at posterior border extends over head of adductor magnus. *Sylvilagus*, same. *Ochotona*, fleshy, from pubic ligament to posterior extremity of ischium. Insertion: *Lepus*, by broad fascia on medial border of tibial crest and patellar ligament. This fascia is also fused with the tendon of the semimembrano-



FIGS. 5 AND 6. Line AC represents the most direct pull of the tensor fasciae latae and rectus femoris anterior. Note the sharper angle of pull in *Lepus*.

sus and in turn is fused with the tendon of the soleus, and is thus inserted on the calcaneus. *Sylvilagus*, same, but only slightly attached to tendon of semimembranosus, and fascia of insertion is relatively shorter. *Ochotona*, fleshy, on medial border of tibial crest. In *Lepus* and *Sylvilagus* this is a triangular muscle, distinctly thickened near its origin. In *Ochotona* the muscle is strap-like, being about the same breadth and thickness throughout.

MUSCLES OF THE LOWER LEG

Tibialis anterior. Origin: Fleshy from lateral condyle of tibia and lateral border of tibial crest. Insertion: By long tendon that passes beneath the crural ligament to be attached to the lateral surface of the proximal end of the second metatarsal.

Extensor digitorum longus. Origin: By short tendon originating from articular surface of lateral condyle of femur. The tendon then passes over the head of the tibia, where it joins the fleshy portion. Insertion: By long tendon that passes first beneath the crural ligament and then beneath the cruciate ligament of the dorsum of the foot, where it divides into four parts, to be inserted on the dorsal border of the distal phalanx of each of the four developed digits.

Extensor hallucis longus. Origin: Fleshy from posterior border of medial condyle of tibia and medial proximal surface of the tibia to distal end of tibial crest. Insertion: *Lepus*, by long tendon that passes down medial surface of tibia and beneath base of first functional metatarsal; continuing, it becomes palmate and divides into two portions that shift to the top of the foot. Here these unite with the tendons of the extensor digitorum longus, to be inserted on dorsal borders of the distal phalanges of the first two functional digits. *Sylvilagus*, similar to that of *Lepus* but the attaching tendon does not become palmate nor does it divide; it is inserted on the distal phalanx of the first functional metatarsal only. *Ochotona*, same as *Sylvilagus* but not fused with tendons of extensor digitorum longus. This difference in the tendons of insertion in *Sylvilagus* and *Lepus* is evident in two specimens of each species.

Peroneus longus. Origin: Fleshy from lateral condyle of tibia and head of fibula. Insertion: By long slender tendon that passes down lateral surface of tibia, beneath lateral malleolus of tibia. Continuing, it passes around distal end of cuboid bone, and across plantar surface of foot to be attached to the proximal plantar process of the first functional digit. Slightly fused near its origin to peroneus digiti quinti.

Peroneus brevis. Origin: Fleshy from lateral surface of fibula and proximal half of tibia. Insertion: By long tendon on proximal lateral process of fifth metatarsal. Fused near its origin to peroneus digiti quarti; fusion more evident in *Ochotona*.

Peroneus digiti quarti. Origin: Fleshy from proximal lateral border of fibula and interosseous ligament. Insertion: By long slender tendon on distal end of third functional metatarsal and proximal end of first phalanx of same digit. Fleshy portion fused with flexor digitorum longus and peroneus brevis.

Peroneus digiti quinti (= Peronaeus tertius of Bensley). Origin: Fleshy from head and proximal lateral border of fibula. Insertion: By long, slender tendon on distal end of fifth metatarsal and on dorsal surfaces of phalanges of the same digit. In *Sylvilagus* and *Ochotona*, extensively fused near origin to flexor digitorum longus; less fusion in *Lepus*.

Gastrocnemius. Origin: Two fleshy portions from the lateral and medial epicondyles of the femur and their respective sesamoids. Insertion: By long tendon on posterior inferior border of calcaneus. Lateral portion slightly fused with the soleus at the distal end of the fleshy portion.

Plantaris. Origin: Fleshy from lateral epicondyle of the femur and its sesamoid, and the intercondyloid fossa. Insertion: By long tendon that passes over the calcaneus, thence along the plantar surface of the foot, where it becomes palmate and divides into four tendons to be attached to the proximal ventral borders of the second phalanx of each of the four developed digits.

Soleus. Origin: By short tendon from head of fibula. Insertion: By long tendon on posterior inferior border of calcaneus. Slightly fused with gastrocnemius at the distal end of the fleshy portion.

Popliteus. Origin: By short heavy tendon from lateral condyle of femur. Insertion: By tendon that passes obliquely to the posterior surface of the knee-joint, where it becomes fleshy and heavy and has a broad fleshy attachment to the posterior medial surface of the proximal end of the tibia. The popliteal sesamoid is inclosed in this muscle at the union of the fleshy and tendinous portions. In *Ochotona* the area of insertion is proportionately longer than in *Sylvilagus* and *Lepus*. Note that the origin of this muscle is tendinous and the insertion is fleshy, which is the reverse of the condition found in the other muscles of the hind limbs.

Flexor digitorum longus (of Bensley). Origin: Fleshy, from lateral condyle of tibia and head of fibula. Insertion: By long, heavy tendon that passes over distal end of tibia and continues to plantar surface of foot, where it divides into four portions to be attached to the proximal borders of the distal phalanges of the four functional digits. This muscle and its tendon is composed of at least four portions that can be partially separated. The fleshy portion is slightly fused to the peroneus digiti quarti.

Flexor hallucis longus and tibialis posterior do not occur as separate muscles.

In conclusion: The muscles and bones of the hind limb in *Lepus* combine those principles that result in great speed and endurance, whereas these structures in *Ochotona* and *Sylvilagus* are adapted to produce quickness of motion but neither great leaping ability nor endurance.

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THE MAMMALS OF NORTH MANCHURIA

By A. S. Loukashkin

In the spring of 1935, the Manchuria Research Institute sent an expedition under my leadership into Barga for study of the fauna of the Dalai Nor Lake and adjacent territory. This lake appears to be the largest within the limits of Manchoutikou.

The Expedition left Harbin on May 7, and reached the appointed place on May 15, where it remained till June 20, and then returned to Harbin on June 23. Thus, 36 days were spent by the expedition in the field.

The base camp of the Expedition was established at the mouth of the Urshun River, on the eastern shore of the Dalai Nor Lake, where the fishery managed by Mr. Borissov is located. There we made observations, mainly on the birds and mammals.

From this point I made a trip of reconnaissance by cart up the Urshun River toward the Lama-Gure monastery, and to Ulan Nor Lake (Red Lake); then I proceeded northward to Mt. Bogdo-Ula (Sacred Mount). After that I returned to the base by the same route.

In the autumn of that year I visited the western shore of the Dalai Nor, where I travelled from September 28 until October 15. There I studied the marmot (tarbagan) on the high steppes on the western lake shore.

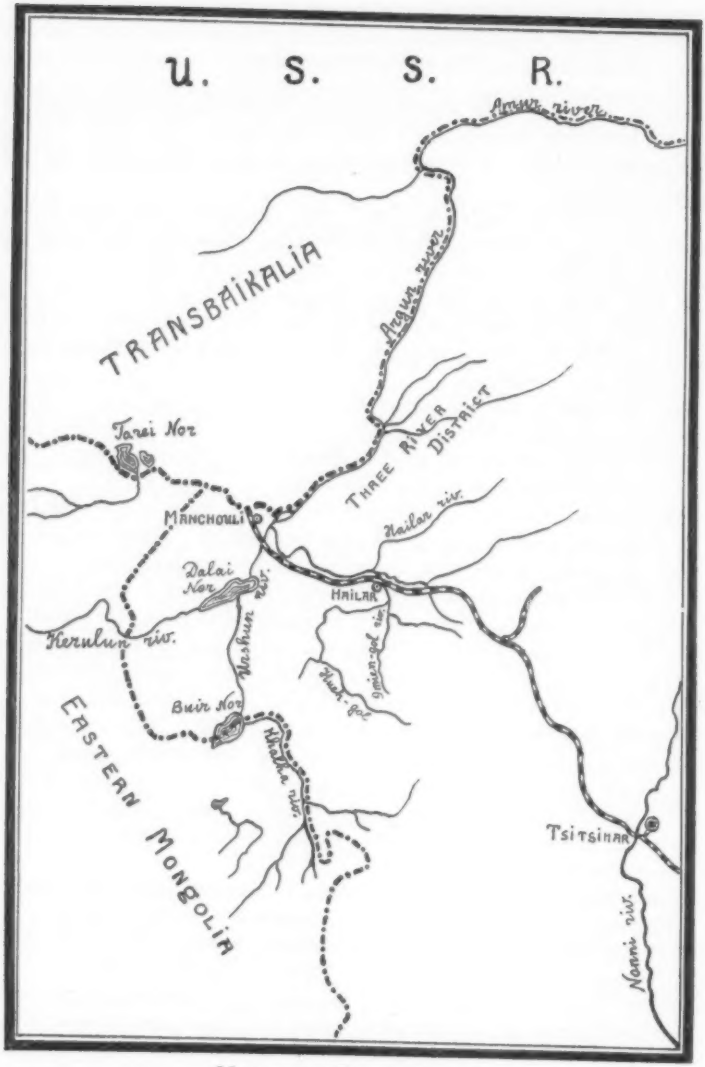
All the localities investigated by the expeditions, except the steppe, are semi-desert in character, being a direct extension of the neighboring parts of eastern Mongolia and Dauria. On such a naked and dismal landscape we met with a typical Mongolian mammal fauna, which is quite impoverished. Below I give a list of these mammals with brief data on their distribution.

Erinaceus dauuricus Sundevall, Daurian hedgehog.—This was collected at the mouth of the Urshun River in growths of *Lasiogrostis splendens*, and on the sandy shore of the Dalai Nor not far from the base, where it is not rare. The main food consists of small rodents, living there in countless colonies. It was captured in tin boxes, sunken in the ground along the paths in the colonies of voles and jerboas.

The following places in Barga are known to be inhabited by this interesting hedgehog: Environs of Mamchouli, steppes near Khorhonte with sand dunes ("barkhans") covered with Turkestanian willows (*Salix ledeburiana*); and high steppes around Hailar, on the Chinese Eastern Railway.

Nyctalus (sp. ?).—Eleven females of some species of this genus were secured from under the roof of an uninhabited cottage at the mouth of the Urshun River. Some of them contained half-developed embryos. The specimens were sent to S. I. Ognev for determination but have not yet been returned.

Putorius eversmanni michnoi Kastsch, Transbaikalian steppe fitch. No specimens were collected by the Expedition, but a single skull of an adult male was received from a Russian trapper who secured it during the past



MAP OF THE BORGA DISTRICT

winter near Mr. Kataev's fishery (70 kms. up stream from the mouth of the Urshun River) in the Solonetz steppe. In the high steppes surrounding the northern and western shores of the Dalai Nor, it is distributed more widely and is met with more often. Its burrows and sign on the stony slopes of the hills near Ikhe-Bulun were found almost every day. This fact is easily explained by the presence of the colonies of tarbagan (*Marmota*). The tarbagan constitutes the main item in the diet of the fitch. It is widely distributed all over the Barga steppes, Three Rivers district, and on the western forested slopes of Great Khingan Mountains. Measurements of the skull: total length, 69; condylobasal length, 70; basal length, 64; zygomatic breadth, 39 mm.

Mustela nivalis pygmaea J. A. Allen, Weasel.—We found four mummified specimens of weasels in white winter pelage, killed by the Daurian fox and left in its burrows. Twice during my trip by cart along the Urshun River I noticed on the road flattened and dried bodies of weasels, that probably had been crushed by cart wheels. I also observed its sign on the sand dunes near the mouth of the Urshun River, where it hunted Daurian pikas and other small rodents. It is known from the vicinity of Hailar, Miandukhe on the Chinese Eastern Railway, and from Great Khingan Mountains (Irekte and Tchol rivers).

Meles leptorhynchus raddei Kastsch, Daurian badger.—I have found the burrows of this badger, as well as its foot prints, on the silt and wet sand of the Ulan Nor, but in the vicinity of our base at the mouth of the Urshun River the badger does not occur. Again we found its burrows only in the northern part of the eastern shore of Dalai Nor, at the old mouth of the Argun (or Hailarho) River. On the western shore of the Dalai Nor, badgers are very scarce, but in the valley of Hailarho they are met with more often. Ten or 12 years ago they were quite abundant around lakes Tsagan Nor and Kuku Nor, which are situated close to the intersection of the Morgel and Hailarho rivers.

Canis lupus argunensis Dybowski, Argun wolf.—This is a very common beast all over the localities visited by the expedition. I have seen wolves and their burrows near the Ulan Nor, and on Mount Bogdo Ula. A series of skulls was received from Russian hunters, who poison wolves with strychnine in winter. Elsewhere in Barga the wolves are harmful, because they prey upon the herds of the Bargut cattle and sheep breeders.

Vulpes vulpes daurica Ognev, Daurian light-colored fox.—This subspecies of red fox, recently described, occurs over the steppes surrounding the Dalai Nor. I found several burrows on Mount Bogdo Ula and near the mouth of the Urshun River. In the latter place I excavated one burrow and secured 3 young foxes with their mother, but the male escaped. This fox is distributed over the whole Barga and Three Rivers district. Some skulls were presented to the expedition by Russian hunters.

Vulpes corsac Linn., Mongolian sand fox.—This animal is quite scarce. The fishermen told me that the burrows of this small fox are met with in the southern part of the Dalai Nor, called Uzur-Dalai, and much more frequently in the region of the lower Korulun River. In those places they breed in the summer, but after the first fall of snow they begin to wander in all directions. In the middle of winter they approach close to the Chinese Eastern Railway line, and hunters then poison them at Manchouli, Khorhonte, and Hailar stations. I am informed that the sand fox inhabits the sandy "barkhans" between the Ganjour Sume and Arshan Sume monasteries. A series of skulls was received from Russian hunters.

Otocolobus manul manul Pallas, Mongolian steppe cat or manul. On June 10 I shot an old cat in the rocky cliffs of Mount Bogda Ula. At that time this animal had completely changed its winter coat for the summer one. On the flat, sandy eastern shore of the Dalai Nor, the manul is rather rare, but on the opposite side it is distributed much more widely, because here there are numerous rocky cliffs, which appear to be the best shelters for this cat. When I stayed at Mr. Sapelkin's fishery near the Urtui-stream, the manul attacked and killed a domestic hen. Russian trappers state that the manul inhabits the extreme western parts of the Barga close to the Eastern Mongolian frontier, where the population is sparse. Measurements of the body of the specimen killed: Head and body, 455; tail, 295; ear, 40; hind foot, 100 mm.

Citellus dauricus dauricus Brandt, Daurian ground squirrel or suslik.—This animal was found in abundance near the mouth of an old bed of the Argun River, and on the eastern shore of the Dalai Nor from Mount Holboi to the mouth of the Urshun River. Between the mouth of the Urshun River and Lama-Gure monastery I met with it frequently. It is known from the vicinity of Manchouli, Tsagan and Hailar stations, and from the Three Rivers district.

Marmota sibirica (Buchner), Tarbagan or Siberian marmot.—The scanty remnant of a tarbagan colony was discovered on Mount Bogdo Ula. Tarbagans still exist on the western shore of the Dalai Nor, and in the neighborhood of Manchouli station, but in very limited numbers. Not long ago colonies of tarbagans occurred in the foothills of the Holboi Mountains, where they have been exterminated. I collected 3 young specimens near Urtui-stream and Manchouli station.

Meriones unguiculatus (A. Milne-Edwards), Jumping rat or jerboa.—This rodent is very numerous on sandy, semi-barren places near the mouth of the Urshun River. It is not known from other localities in Barga.

Mus bactrianus mongolium Thomas, Mongolian house mouse.—I refer to this subspecies the specimens collected by the Expedition. This mouse has been found both in dwellings and in the wild. Its burrows were made in growths of *Nitraria shoberi* and *Lasiogrostis splendens*, on the alkaline soils on the western shore of Dalai Nor near Ikhe-Bulun.

Cricetulus furunculus furunculus Pallas, Daurian hamster.—Several specimens were secured at the mouth of the Urshun River, and I observed them also not far from the Ulan Nor. It is less numerous than the Zungarian hamster.

Phodopus (Cricetiscus) songarus campbelli Thomas, Zungarian hamster.—This animal was collected by the Expedition only on the eastern shore of the Dalai Nor. It occurs also in abundance near Manchouli station, but farther east it is progressively scarcer. Beyond Hailar station it is unknown.

Microtus (Stenocranius) gregalis raddei Poljakov, Transbaikalian narrow-skulled vole.—Colonies of this vole were very numerous near the fishery of Mr. Borissov (at the mouth of the Urshun River on the eastern shore of the Dalai Nor), amid growths of *Lasiogrostis*. In the other localities visited it was not detected.

Microtus (Lasiopodomys) brandti (Radde), Brandt vole.—This appears to be the most numerous of all the mammals in the localities visited. The areas occupied by its colonies on the eastern shore of the Dalai Nor stretch as far as 15 to 20 kms. The colonies were situated no less than 400 meters from the edge of the lake. In the upper part of the Urshun River near the Ulan Nor I could find not a single specimen. On the western shore of the Dalai Nor, however, they were found in several places, but not in such countless numbers as on the eastern shore. Near Hailar station I first met with this vole in August, 1934.

Alactaga mongolica mongolica (Radde), Alactaga, or Mongolian jerboa.—This animal is not rare on the eastern shore of the Dalai Nor, and near Manchouli, Tsagan, Djalainor, Khorhonte, Wangun, and Hailar stations. Beyond the Great Khingan Mountains it appears again in the valley of the Nonni River, and Soda Steppe between Tsitsihar and Manklu stations on the Chinese Eastern Railway (Heilunkiang Province).

Ochotona (Ochotona) daurica (Pallas), Daurian pika.—A series of skins and skulls of the Daurian pika was collected by the Expedition, mainly on the eastern shore of the Dalai Nor, at the mouth of the Urshun River, where they make their numerous burrows in the sand dunes covered with rough grass and low bushes of *Caragana microphilla*. I observed this rodent also on Mounts Bogdo Ula and Holboi, and on the western shore of the Dalai Nor not far from the Ikhe Bulun and the Urtui-stream. Thousands of hay-heaps, prepared by Daurian pikas as a winter food, were observed in August, 1934, between Ganjour Sume and Arshan Sume. Several times I have found it in the vicinity of Hailar, but there it is not so numerous as in the central portions of Barga.

Lepus tolai tolai Pallas, Tolai hare.—This hare occurs in small numbers in the basin of Dalai Nor Lake, where it keeps to the localities along the banks of the Urshun River and lake shore. Here it is found in high grass, in which it finds safety. It is widely distributed all over Barga, but is concentrated in great numbers in the sand dunes near Khorhonte, and in the valley of the

Hailarho River. Following this valley up stream, it penetrates deeply into the forested zones of the Great Khingan Mountains, where it occasionally crosses with the local race of *Lepus timidus*.

Antilope gutturosa gutturosa Pallas, Mongolian steppe antelope.—On the eastern shore of the Dalai Nor, this animal was found in two places only; near Uzur Dalai, and Holboi, where there were very few. On the steppes adjacent to the western shore it stays the year round, approaching in the winter close to settlements, especially the hay-stacks. In cold winters the antelopes reach Hailar, and even the Three Rivers district, wandering throughout all Barga in herds consisting of a thousand or more individuals.

Remarks.—Including the mammals, collected or observed in the basin of Dalai Nor Lake, I should like to mention also the mole-rat, *Myospalax* sp., which I did not find, but which is encountered not far from this region. I observed traces of its activity between Khorhonte and Tsagan stations. Sand dunes or "barkhans," covered with occasional willow bushes and solitary pine trees, are crossed here by the Chinese Eastern Railway. Cone-shaped heaps of wet sand, made by the mole-rats, stretch along the railway track, sometimes like a chain reaching hundreds of meters in length.

The "barkhans" inhabited by *Myospalax* are very extensive. Beginning at Khorhonte, they continue through Ganjour Sume southward to the Hueh-Gol River. Here, in August of 1934, I observed countless heaps of soil excavated by mole-rats. Following the valley of the Hueh-Gol River they reach Great Khingan Mountains. It is quite possible that *Myospalax* has penetrated the low-lying sandy-steppe regions from the forested mountainous locations of Great Khingan, but not *vice versa*.

It is interesting to note that near Hailar there are now no living mole-rats, but their skeletons occur in subfossil state. The nearest place inhabited by this mammal appears to be railway post N16, situated between Hake and Djaromte stations on the Chinese Eastern Railway.

Conclusions.—Of the 21 forms listed in the present article, comprising the mammal fauna of the basin of the Dalai Nor Lake and the Urshun River, the chief place, both in number of species and of individuals, is occupied by the order Rodentia (11). Next in numbers are the Carnivora (7). Insectivora, Chiroptera and Ungulata each have but one representative in northwestern Barga. All of these mammals appear to be true inhabitants of the open stretches of Dauro-Mongolia, which, penetrating through the Barga steppes into North Manchuria, communicate a typically Mongolian character to the mammal fauna of this region. Of these 21 mammals, 12 are now recorded from Manchuria for the first time.

North Manchuria Museum, Harbin, Manchuria.

THE BREEDING SEASON OF THE MUSKRAT IN NORTHWEST IOWA[1]

By Paul L. Errington

Despite the tremendous economic importance of the muskrat (*Ondatra zibethica*) over much of North America and the volume of popular literature on this animal, actual data on its breeding in a state of nature have been surprisingly limited. Hence, it may be useful to present at this time a resumé of certain data that have been obtained in connection with recent field studies carried on chiefly at Round and Mud lakes, near Ruthven, Iowa. Round Lake is a state wildlife refuge and marsh of about 450 acres, and Mud Lake is a marsh, largely privately owned, of about 400 acres.

Seasonal Distribution of Litters.—After preliminary work on Round and Mud lakes during the summer of 1934, it was considered desirable to make the research program one of intensive investigation, by which weight, measurement and other data would be secured on as many local litters as possible throughout the breeding season.

The data on seasonal distribution of litters pertain to muskrat populations of both Round and Mud lakes in 1935, and almost exclusively to the Round Lake population in 1936. While the summer of 1935 was unusually wet in this locality, and the summer of 1936 was one of severe drought, these extremes of conditions appeared to have no significant influence on the breeding of the populations with which we are concerned in this paper. It should then be permissible to summarize for convenience the data for 1935 and 1936 as in Table I.

From Table I it may be seen that the main breeding season in this region occurs during the months of May, June, and July, with the first young born in the latter half of April, and a few late litters coming in the second half of August. The "kits" frequently caught by trappers in mid-November compare in size with animals known to be between 70 and 90 days old, and so probably represent August young.

In central Iowa the breeding season may be more extended; one litter was recorded northwest of Des Moines for which the date of birth was calculated as April 3, 1936, and, on September 13, a female that had evidently died after parturition some hours before was found northwest of Ames. Extremes greater than these doubtless may be expected on rare occasions, and we have one not wholly verified report of a female with fetuses having been trapped near Ruthven in late November or early December, 1936.

Number of Litters per Female per Season.—The studies for 1936 were centered upon, but not confined to, Round Lake for the primary purpose of

[1]Journal Paper No. J444 of the Iowa Agricultural Experiment Station. Project No. 498. In coöperation with the U. S. Biological Survey, the American Wildlife Institute, and the Iowa Conservation Commission.

attempting to secure data on every litter of young muskrats born on the marsh from April to October. All known muskrat habitations showing evidence of use were assigned numbers, and for reference their locations were plotted on a field map. The majority of these were lodges with chambers of the sort that are commonly used as nests for the young, and were systematically examined by hand (but with very little disturbance, as a rule) on an average of once in 10 days for the duration of the main breeding season, and at generally sufficient intervals for the balance of the season to detect unusually early or unusually late litters.

From spring to mid-summer the lodges were fairly accessible by means of a canoe operated by the author and his wife; in late summer and fall, low water and rank growths of vegetation necessitated more wading and increased the likelihood of newly constructed lodges being overlooked. The drought, on the other hand, simplified the work by forcing the abandonment of almost

TABLE I

SEASONAL DISTRIBUTION OF 282 MUSKRAT LITTERS IN NORTHWEST IOWA, 1935 AND 1936

PERIOD OF BIRTH	NUMBER OF LITTERS	PERIOD OF BIRTH	NUMBER OF LITTERS
April 1 to 15	0	July 1 to 15	39
April 16 to 30	13	July 16 to 31	17
May 1 to 15	39	August 1 to 15	7
May 16 to 31	49	August 16 to 31	4
June 1 to 15	53	September 1 to 15	0
June 16 to 30	61		

all of the bank runways of Round Lake, thus restricting practically the whole muskrat population to lodge habitats for much of the summer.

In many instances—particularly in the more densely populated sections of the marsh—no method could be devised by which the maternity of successive litters could be satisfactorily traced to a specific female. Forty-four of the total of the 106 litters handled, however, were judged with reasonable certainty to be the offspring of 21 females. Criteria for appraising the reliability of breeding data from a given habitat and its population included visibility in the marsh surrounding the habitat; remoteness from other occupied habitats; apparent extent and definiteness of muskrat home ranges over periods of time; living routines and idiosyncrasies of individuals; recoveries of young marked with numbered aluminum tags; and relative completeness of records on the whole.

Of the 3 females of Table II to each of which a single litter was attributed, the ones that gave birth to their young about June 21 and July 13 lived in isolated, easily observable habitats. The muskrats noted in these places in April and May were solitary and evidently unmated individuals.

Two litters seemed to be the usual number per female, on the basis of 12 apparently reliable instances. Three litters per female does not seem to be of infrequent occurrence, as 5 apparent cases were recorded, including one of a female found dead with the third litter *in utero*.

Incomplete though strong evidence of 4 litters was found for 1 female. Only 3 of the litters were actually handled, but the last to be born was in all

TABLE II

BREEDING RECORDS FOR 21 FEMALE MUSKRATS, ROUND LAKE, RUTHVEN, IOWA, 1936

INDIVIDUAL FEMALE	EVALUATION OF DATA	DATES OF BIRTH OF LITTERS, KNOWN OR CLOSELY CALCULATED	INTERVALS IN DAYS BETWEEN DATES OF BIRTH, AS DETERMINED
♯1	good	June 16	
♯2	excellent	" 21	
♯3	good	July 13	
♯4	excellent	May 7 and June 13	37
♯5	good	" 8 " " 7	30
♯6	good	" 8 " " 10	33
♯7	good	" 10 " " 14	35
♯8	good	" 19 " " 20	32
♯9	good	" 24 " " 26	33
♯10	excellent	" 26 " " 28	33
♯11	good	" 28 " " 21	24
♯12	excellent	" 30 " July 13	44
♯13	excellent	June 7 " " 6	29
♯14	good	" 12 " " 11	29
♯15	excellent	" 16 " " 15	29
♯16	excellent	Apr. 30, May 31, July 4	31, 34
♯17	excellent	May 7, June 9, July 13	33, 34
♯18	excellent	May 12, June 14, July 15	33, 31
♯19	good	May 16, June 10, female dead June 27 with embryos of about 12 mm.	25, ?
♯20	good	June 2, June 21, July 23	19, 32
♯21	good	May 26, June 23, (?) —, Aug. 24 (no litter was recorded for late July but very probably one was born about this time)	28, 31 (?) 31 (?)

probability the fourth; successive litters usually come at intervals of about a month, and there was a space of 62 days between the birth of the second and the last litters.

Do Early Young Breed the Same Season?—There is a wide-spread belief among trappers that the young of early litters may themselves breed in the fall, a view probably founded largely upon the occurrence of "kits" in the

winter catches (C. E. Johnson. Roosevelt Wild Life Bulletin, vol. 3, pp. 205–320, 1925). In northwest Iowa, the chances of young muskrats breeding in the year of their birth are negligible, as the following data on rate of maturity may illustrate.

Coöperating in the Round Lake research program, the Iowa Conservation Commission took 71 muskrats for specimens in November, 1936, and 110 more in December. Post-mortems of these disclosed no sign of current reproductive activity. Young of the season could readily be separated from the adults by macroscopic examination of the gonads. The 181 late fall and early winter specimens gave an age ratio of 49 adults to 132 young, of which the latter included 12 tagged individuals of known ages ranging from 161 to 222 days.

No material was examined histologically, but the specimens fell so decidedly into one age class or the other that there could hardly be likelihood of error. The testes of obviously adult males were rather uniformly about 15 mm. in length, 9 in breadth, and 5 in thickness; those of the largest and oldest young did not exceed 10 by 6 by 4 mm. in size, with the average of 14 sets of testis measurements being 8.2 by 6.1 by 3.9 mm. The oldest young of established age were born in early May and were still plainly immature at nearly 7 months, or at the time that they were collected in mid-December.

Indirect Evidence on Gestation Period.—The gestation period of the muskrat has long been a matter of question. The most reliable experimental evidence of which I am aware is that kindly supplied by Frank G. Ashbrook, of the U. S. Biological Survey. According to his data, one litter was born to a captive female that had been exposed to a male 9, 19, and 29 days previously; another female gave birth to young after having been exposed to a male 15 and 30 days preceding. "From the two records . . . it appears that the gestation period of the muskrat is 29 or 30 days."

This figure checks so closely with the majority of the intervals between births of litters given in Table II, that there may be a temptation to attribute to error the three materially shorter intervals listed—19, 24, and 25 days—especially since no one of the shorter intervals is recorded on the basis of data evaluated as excellent.

Nevertheless, the shorter intervals may have potentialities of extreme significance and may well merit further discussion. Svihla (Misc. Publ. no. 24, Mus. Zool., Univ. Michigan, 1932), working on deer mice, reported that the females of *Peromyscus* are usually in heat immediately following the birth of a litter, and that the gestation period of *P. maniculatus* varied from 22 to 35 days in 89 cases, and of *P. leucopus* from 22 to 37 days in 45 cases. Prolongation of gestation in the deer mouse was associated with lactation, but not with greater numbers of embryos carried, nor with size of adults. Similarly, it is entirely within reason that the gestation period of the muskrat may be subject to much variation within limits so far undetermined.

The 19-day interval given between births of the first and second litters of female no. 20 (Table II) apparently is close to a true gestation period but one that is probably atypical. Three young of the first litter were examined at a calculated age of 8 days, and these appeared to be of normal development at that time. During the next 11 days prior to the birth of the litter judged to be the second, they grew with remarkable rapidity, attaining by the age of 19 days an average weight of 128 grams and an average total length of 256 mm. For comparison, it may be stated that the average weight of 24 other 19-day young was 97 grams and the average total length was 221 mm. The three large young were, moreover, *behind* schedule for their size in the opening of the eyes, in development of pelage, and in defense reactions. If the female were one of great vigor and lactating powers, precocity of young in utero might conceivably accompany precocity of suckling young.

Table II contains no data that are not of evidently good quality, but data from 8 other two-litter females seem to be only a little less reliable. For these, the intervals between births were 22 days in 1 case; 23 days in 2; 27 days in 1; 32 days in 1; 34 days in 2; and 36 days in 1.

The indications, then, from the field data, so far as they go, seem to be that the period of gestation may vary from a probably atypical minimum of near 19 days, to a probably more usual minimum of 22 or 23 days, with the ordinary period probably being around 30 days, as suggested by the Biological Survey experimental data.

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ACTIVITY RHYTHMS IN BATS UNDER CONSTANT EXTERNAL CONDITIONS

By Donald R. Griffin and John H. Welsh

Many animals, vertebrate and invertebrate, show a periodicity of general activity that persists under constant external conditions. One of the characteristic rhythms is based on the 24-hour cycle of daylight and darkness. Most animals are either definitely nocturnal, diurnal or crepuscular, and there is a definite time of day or night at which their normal activity begins. The surprising fact is that many animals when placed in constant darkness continue to show the same periods of activity and rest. Even after several weeks in total darkness the activity rhythm may be in phase with outside daylight and darkness.

Persisting daily rhythms of activity have been observed in the laboratory rat by Richter (1922) and Browman (1936), in the deer mouse *Peromyscus* by Johnson (1926), in the meadow vole *Microtus* by Davis (1933), in the Japanese waltzing mouse by Wolf (1930), in insects by Lutz (1932), Park and

Keller (1932), Park (1935), and Park and Sejba (1935). These are only a few of many cases that have been recorded.

It seemed possible that bats might be suitable animals for experiments on these activity rhythms, as they have a very marked periodicity in their normal habits. When they are not hibernating, bats of the genera *Myotis*, *Pipistrellus* and *Eptesicus* spend the daytime asleep. These bats emerge shortly after sundown and a whole colony of several hundred may leave the roost within a few minutes. Often, if food be plentiful, the bats return to their roost in a couple of hours. There may be a second period of activity in the early morning.

Three little brown bats, *Myotis l. lucifugus*, were secured in June, 1936, from a summer colony in Hatchville, Massachusetts, and records of their general activity were obtained. Bats are not easily fed in captivity, but it was possible to keep them alive and healthy by feeding live mealworms by hand. This process required considerable time in addition to that needed to keep the records. It was thus necessary to have the lights on for about one hour while the bats were being fed, and this was done at different times of the day so as to avoid, if possible, setting up any unnatural rhythms by these disturbances.

The bats were placed in small cages suspended by rubber bands. A cage was connected to a writing lever that traced a line on the smoked paper of a revolving kymograph drum. When the cage was motionless the writing point traced a straight line. Any movement of the bat caused the cage to oscillate and produced a deflection of the writing point. In this connection we wish to express our gratitude to Dr. T. J. B. Stier for his kindness in allowing us to use his apparatus in these experiments. We found that some of these records would not stand photographic reduction, and we adopted a graphic method of reproduction.

Figure 1 shows a series of reproductions of typical records obtained from one of the bats in June, 1936. Each horizontal base line represents 24 hours from noon to noon. In these June experiments the bats were fed once a day, and this period of feeding and disturbance is shown by a break in the base line. The full height blocks indicate main periods of activity, and the low blocks, periods of slight but continuous activity. Single movements are shown on the records by a single short line. The heavy black line below the base line indicates complete darkness. During the first three days of this experiment the bats were kept in subdued daylight, approximating the light conditions of their roost. Here the heavy black line shows the period from sunset to sunrise, about 7:20 P.M. to 4:10 A.M. E.S.T. It is apparent that under these conditions, just as in their normal wild state, the bats had their principal period of activity in the early evening just after sunset.

On June 15, the shades of the darkroom were lowered completely, and the bats were in constant darkness except when being fed. This is indicated in

the figure by a continuous black line below the base line. It is obvious from a glance at these records that the main period of activity continued to occur at about the normal time during the 4 days that the bat was in constant darkness.

These experiments could be continued for only 4 days in constant darkness, and we repeated and extended them during October, 1936. At this time of the year the bats are beginning their hibernation, and two completely dormant *Pipistrellus subflavus* were procured from a cave in western Massachusetts. These bats are closely related to the *Myotis* used in June, and have similar habits. They were kept at normal room temperature in the labora-

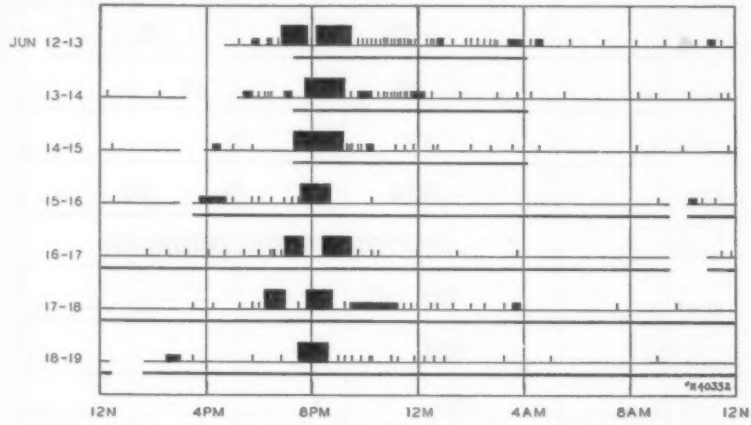

FIG. 1. Periods of activity of *Myotis l. lucifugus* no. H40332 (June, 1936). Solid blocks above base line indicate approximate duration and extent of activity. Heavy black line below base line indicates periods of complete darkness. Breaks in the base line represent disturbances necessary for changing records and for feeding.

tory and fed meal worms. When fed regularly and kept at room temperature, bats do not hibernate; their body temperature remains fairly high and they sleep between periods of activity just as in summer.

These *Pipistrellus* were kept in a sound-proof room in the sub-basement of the laboratory where temperature and humidity were quite constant and where no external noises could possibly enable them to distinguish night from day. Forty-eight-hour kymographs were used and the bats were fed at two-day intervals instead of daily as in June. The time of feeding again was intentionally varied so as to avoid establishing any artificial rhythms.

Activity records of these two bats were taken for about two weeks. The animals were in total darkness except for the disturbances necessary for feeding, and other external conditions, such as temperature and humidity,

were practically uniform. Figure 2 shows the activity record for one bat (*Pipistrellus* no. 1). It is clear that the main period of activity again came in the early evening of every day, regardless of the time of feeding. On two occasions, October 21 to 22 and October 25 to 26, this bat was active throughout the night, and in both cases we found that the water dish was dry. Apparently the animal was restless because of thirst. The other

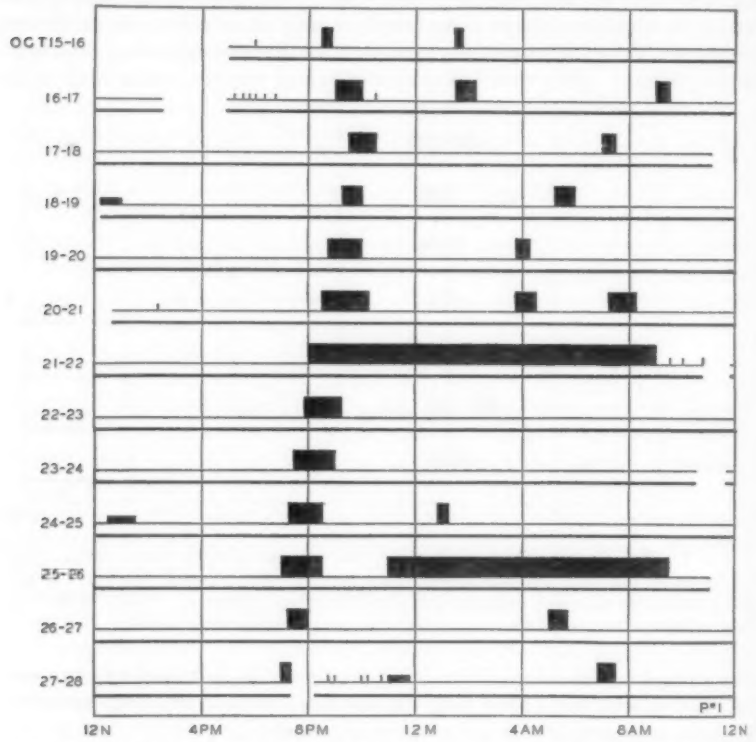

FIG. 2. Periods of activity of *Pipistrellus subflavus* no. 1 (October, 1936). Method of plotting same as fig. 1. Bat kept in constant darkness except when being fed.

periods of activity shown in figure 2 were quite irregular in their time of occurrence, which indicates that the early morning periods of activity are less accurately "timed" than those occurring in the evening.

The records obtained from the other bat (*Pipistrellus* no. 2) show an interesting variation that may occur in these activity rhythms. No regular periodicity could be detected in this bat's activity when the absolute time of

each period of activity was plotted as in figures 1 and 2. But when the records were plotted to show the time that elapsed between a feeding disturbance and the periods of activity, a surprising regularity was disclosed (figure 3).

Here the base lines show the time after each feeding disturbance. In every case there was some slight activity for a couple of hours after the disturbance, and a main period after 20 to 24 hours. Whenever the record was taken for a full 48 hours, there was more or less activity about 44 to 48 hours after feeding.

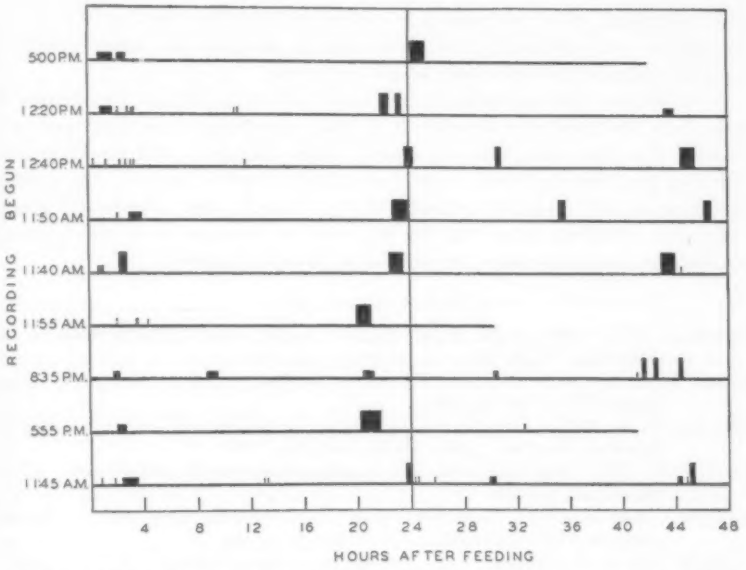

FIG. 3. Periods of activity of *Pipistrellus subflavus* no. 2 in constant darkness (October, 1936). Time plotted as hours after feeding.

Apparently both the bats used in October had 24-hour activity cycles, but one bat's cycle began when he was fed and disturbed, and in the other case the main period of activity occurred at about the same time every day, regardless of the time of feeding. This apparent contradiction may not be as serious as it appears. There is some reason to believe that activity rhythms are based on some cyclic internal process—involving perhaps the nervous or endocrine systems or both. If this be the case, such a rhythm would normally be emphasized by the experience of darkness and daylight. It would function perhaps as an auxiliary to the senses—for example to

awaken a mouse at sunset when he is in a dark burrow, or to arouse bats sleeping in a dark cave.

The experimental condition of constant total darkness is probably abnormal for most animals, and when all possible external time cues are removed, it is thought that these internal rhythms manifest themselves in a periodicity of general activity. Certainly the experiments where periodic activity in constant darkness continues for weeks in phase with outside daylight and dark, offer strong support for such a theory.

On this hypothesis it is not surprising to find that in constant darkness, the activity rhythm may be modified by the only changes in the external environment of which the animal is aware—namely the irregular feeding disturbances. It is probably significant that in all cases the main periods of activity occur at approximately 24-hour intervals.

Conclusions—The experiments just described indicate that two genera of bats show the same sort of activity rhythm, persisting under constant conditions, that has been found in several other mammals and invertebrates. The fact that one individual showed an activity rhythm based on the feeding disturbance may possibly indicate that a delicate physiological rhythm is operative. Perhaps when the environment is constant, it is this internal mechanism that stimulates the animal at 24-hour intervals.

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NOTES ON THE SEX RATIO OF THE SNOWSHOE RABBIT

By William L. Webb

While this paper was being prepared, Mr. C. M. Aldous (Jour. Mamm., vol. 18, pp. 46–57, 1937) published an excellent account of some of the activities of the snowshoe rabbit, including a short discussion of the sex ratio. The present paper includes some of the same data used by Aldous, but is based on records of several thousand more rabbits, taken over a longer period of time.

The population properties of the snowshoe rabbit or varying hare (*Lepus americanus phaeonotus* Allen) are interesting because of the economic importance and scientific value of the species. Economically the snowshoe rabbit has both a positive and a negative value. In many forested areas within the range of the species, the success or failure of tree seedlings, both by natural reproduction and in plantations, is dependent on the number of snowshoe rabbits. In such areas rabbit control is often necessary to insure the growth of small trees of desirable species. A thorough understanding of the factors which determine the population of snowshoe rabbits might indicate needed control measures in this case.

In contrast with this negative value, are the positive economic values of the species. Particularly in the eastern United States, snowshoe rabbits are a valuable game species, and attempts have been made to restock areas where hunting or changed environment have reduced or destroyed the population. The snowshoe rabbit also has an economic value in its buffer capacity, often overlooked. In many areas the predator pressure on the more desirable game or fur-bearing species is reduced by the presence of snowshoe rabbits. The population properties of this species, if clearly understood, might indicate management practices that would increase the number of rabbits available to hunters and further reduce the predator pressure on other economically important species.

The scientific values of the snowshoe rabbit, while not as obvious as the economic values, are just as important. The population of this species is definitely cyclic in nature. Studies on the population properties of any cyclic species indicate the effect of cycles in animal numbers, and may lead to an understanding of the causes of cyclic decimations.

This paper is a presentation of data on the sex ratio of trapped snowshoe rabbits, and was based to a large extent on data obtained from Dr. R. G. Green of the University of Minnesota, and U. S. Biological Survey Cooperative Game Disease Investigation. The sex of 3920 snowshoe rabbits, trapped on the Lake Alexander area near Cushing, Morrison County, Minnesota, was accurately determined by Dr. Green and his assistants. This large amount of material, covering a period of nearly 5 years, was made available, and grateful acknowledgment is given for its use. I also wish to make acknowledg-

ment for data on the sex of shot rabbits obtained from the Minnesota State E. C. W.

The trapping was done with rectangular box traps, screened at one end, and with a drop door at the other. The door is closed when the animal steps on the false floor near the center of the trap. In all cases alfalfa hay, as bait, was placed at the screened end of the trap.

Table I shows the number of rabbits trapped on the Lake Alexander area by year, month, and sex, and the total yearly catch by sex. The number of rabbits caught each month of each year varies with the weather conditions, number of traps used, and the length of time the traps were in operation; but with the exception of 1936, well over 600 rabbits were caught each year.

TABLE I

SEXES OF SNOWSHOE RABBITS TRAPPED ON THE LAKE ALEXANDER AREA

	1932		1933		1934		1935		1936	
	M	F	M	F	M	F	M	F	M	F
January	15	13	141	118	68	68	71	59	14	16
February	33	23	126	92	113	98	134	105	11	7
March	74	46	146	106	172	138	87	56	21	18
April	43	53	167	127	111	119	63	85	34	43
May	2	2	4	8	9	12	2	3	14	27
June					1	1	3	5	10	13
July	1			1			1	6	4	12
August						1	4	2	19	14
September							1		9	12
October	13	11								
November	53	77	13	19	17	18	8	7		
December	77	79	49	46	54	51	36	24		
Total	342	304	646	517	545	506	410	352	136	162

Figure 1 is the graphic presentation of Table I. The percentage of males trapped, plotted on the vertical axis, over the months on the horizontal axis, shows a definitely cyclic sex catch. In other words, more males than females were caught from December to April, and more females than males were taken from April to December. The data, in this case, are to a large extent from the winter or "male months", but all available summer records indicate a decided preponderance of females in the catch.

It is not believed that this cyclic trapping of the two sexes indicates a monthly change in sex ratio. It is evident, however, that the two sexes have a variable seasonal attraction to the traps, and this attraction is probably due to the alfalfa hay used as bait.

It seems likely that the cause of this cyclic attraction of the sexes to the bait of the traps lies in the sexual activities of the species. Aldous (1937)

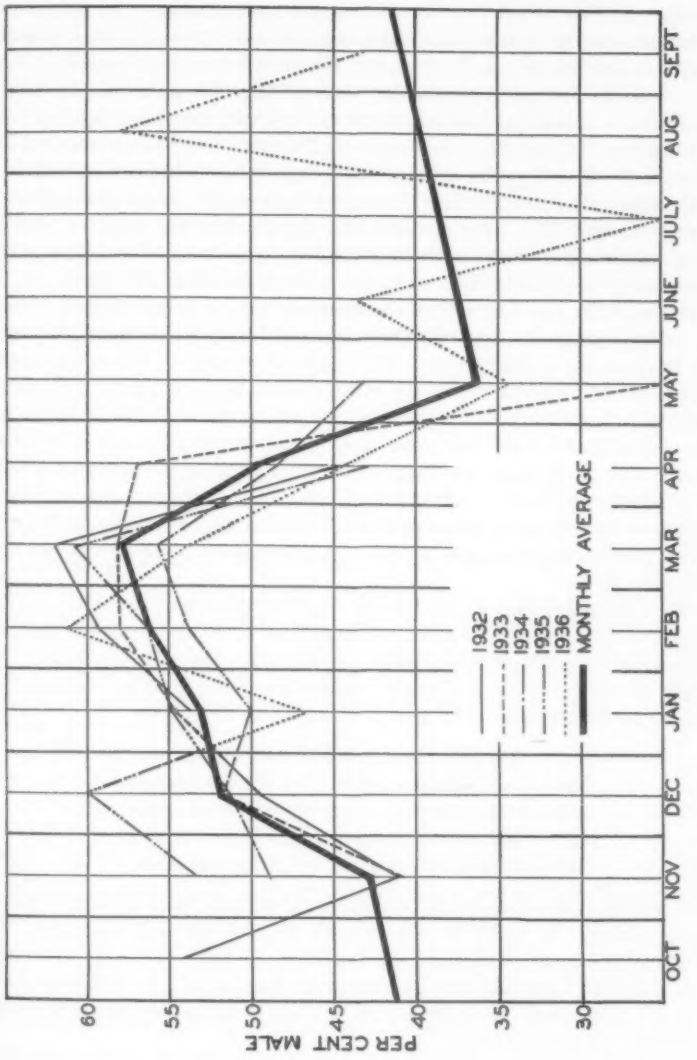

FIG. 1. PERCENTAGE OF MALE SNOWSHOE RABBITS IN THE TOTAL CATCH (BY MONTHS)

has stated that "... in January the testes are very small and somewhat kidney-shaped. At this period they are in the abdominal cavity. In February a marked increase in their relative size and shape is observed, but their position is still intra-abdominal, at least during the early part of the month. Near the last of the month, however, they descend into the scrotum. In March they have about reached maximum size, and by April they are fully distended and remain so through May and June. In July they begin to decrease rapidly in size...." This fixes the greatest male activity as the period from February through June, with the time of greatest increase in size of testes as February and March. The latter months also (fig. 1) show the greatest catch of males, and thus it seems possible that the large percentage of males caught in those months is an indirect result of the increase in size of the testes.

Aldous (1937) has found that the breeding season begins March 15 and ends early in August. Figure 1 shows that the months of April, May, and June have an increasingly larger percentage of females in the catch during the part of the breeding season for which records are available. This seems to indicate that the cyclic trapping of the two sexes is caused by sexual activity. The males enter the traps more readily when they are very active sexually, and the females are taken most commonly at the time when they are called upon to produce, give birth to, and care for their young. If these conclusions be correct, it seems probable that the sexual activity, giving rise to great physiological changes, results in a seasonal sex attraction to the bait used in the traps.

Table I indicates that almost all the trapping records are from the winter months, with only a few observations from May through October. Because of the cyclic sex catch, it is impossible to compute an accurate sex ratio. An analysis of the yearly total of males and females trapped brings to attention another interesting fact. The yearly averages are as follows:

1932— 646 rabbits trapped—52.9% were males.
1933—1163 rabbits trapped—55.5% were males.
1934—1051 rabbits trapped—51.8% were males.
1935— 762 rabbits trapped—53.8% were males.
1936— 298 rabbits trapped—45.7% were males.

The yearly ratio of males to females caught from 1932 through 1935 is fairly constant. It varies from 51.8 male to 55.5 per cent male, with an average of 53.6 male for the four year period. In 1936, however, the yearly sex ratio was 45.7 per cent male, an apparent increase of 7.9 of females in the catch, in a year when the cyclic decimation had reduced the snowshoe rabbit population to a very low level.

From April 21 to May 25, 1936, the Minnesota State E.C.W. crews in Itasca County, Minnesota, shot 386 rabbits, and found a sex ratio of 57.8 per cent male. Over the same period, on the Lake Alexander area (150

miles distant), the sex ratio of trapped rabbits was approximately 35 per cent male. Leopold (Game Management, 1933) stated that "An apparent excess of males has been recorded as often accompanying the cycle-troughs in ruffed grouse, and Schmidt (unpublished) finds an apparent excess of males in Wisconsin pinnated grouse but not in sharptails."

The excess of female snowshoe rabbits trapped in the low of the cycle is difficult to explain, in the face of the evidence of a male excess in shot rabbits and the evidence that other cyclic species show a preponderance of males in the "cycle-trough". It has been suggested that the seasonal cyclic sex catch is due to a differential attraction to the bait of the traps, and it is also possible that the female excess trapped in the years of cyclic decimations may be caused by a similar bait attraction. It seems possible that the cause of cycles might make greater demands on the female rabbits, and thus cause them to seek a better source of food than their usual diet of bark and twigs.

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WINTER NOTES ON THE MOOSE

By William Monypeny Newsom

In Charles Sheldon's "The Wilderness of Denali", page 216, he stated; "November 23rd. While in the woods, I noticed that the snow had been trodden down around a small spruce tree that had been *freshly* rubbed naked and broken by the horns of a caribou bull. Is it possible that the bulls do this to loosen their horns for the purpose of more easily casting them?" As this is the first reference to this question I have seen in print, I should like to add my own notes.

On Tuesday, December 28, 1927, I left mile 36½ west of Oskalaneo (on the Canadian National Railway) in Northern Quebec, going by dog-team north over Tourigny, Brulé, Finger and Lester lakes to Mountain Lake, where we camped. The moose had started to cast their horns about Christmas time. As we were travelling over the lakes, we observed no shed horns until December 31. On that date we found a pair of shed horns together, and several single horns. I noticed at once that all we picked up were covered with sticky sap. At first I thought this must be merely a coincidence. Then I noticed several balsam firs 6 to 7 inches in diameter that were well scarred. From a few feet above the snow (I did not measure the height) to perhaps 6 feet up, they were battered as though someone had been pounding them with the ball of a machinist's hammer. I examined them carefully, but I could not be sure that there was any connection between the sap on the shed horns and the marks on the trees, although each tree had many

moose tracks around its base. My note book does not state exactly how many shed horns we picked up, but I know that there were a dozen or fifteen, perhaps more, and in every case but one that I remember, there was more or less sap on each.

On January 5, 1928, the undrifted snow was 30 inches deep. On that day, my note book records, I found one tree that had been well pounded, where the branches were knocked off 8 feet from the surface of the snow. Then I came to the most interesting bit of evidence I had seen. This was a balsam, double at the base and forked. It stood alone in a very small clearing, perhaps 30 yards across. This tree was 24.55 inches in circumference above the fork. It was well scarred. For a space of two feet, the bark was all knocked off and the sap wood was bare for two-thirds of the way around the tree. Above and below this were many heavy indentations in the bark where the horn points had struck. There was a very apparent difference in the age of these marks. Some appeared to be a few days old and others were very fresh. At the base of the tree was a shed horn probably from a three or four year old bull. I picked it up and it was covered with sap of balsam fir. While I was examining it, I noticed the tip of something protruding an inch above the snow. I dug this out and it proved to be a perfect mate for the other horn. It also was covered with balsam sap. The snow all around the tree was entirely tracked down, as was the whole of the little clearing, as though the moose had spent several days there. The fall of snow that must have partly buried the second horn, occurred about a week before, although I cannot be sure that this was responsible for the horn being covered as it may have been at least partly imbedded by trampling. I spent a half hour or more examining this spot, the marks on the tree, and fitting horn points to marks in the tree, and there was no doubt in my mind that there was nothing casual about this moose's actions. He was determined to rid himself of his horns, and although it had been quite an effort, he stayed at this tree until he had accomplished the work intended. On that same day my notes record that I "found six shed horns today, including the one pair together—all with balsam sap".

Nearly all of these trees were balsam, although I noticed that one or two poplars had been used for this purpose—my notes do not tell how many.

One thing that surprised me was the length of time that the moose had spent at trees. When not at a tree, the moose seemed to keep travelling, rarely stopping for any length of time to feed. This may be a regular habit of moose, but I have spent considerable time in moose country in New Brunswick and elsewhere, and have seen no other trees utilized in this fashion. They were entirely different from the "rubbed" trees, which are scraped through plain friction with the horn, and are familiar to many.

Charles Sheldon's statement, quoted above, that he found on November 24 a *freshly* rubbed tree, presumably means that the marks were not over a

day or so old. On November 19 to 21, he recorded temperatures of minus 7 to 13 degrees; on November 22, 18 below zero; on November 23, 11 below to 10 above. Therefore, the finding of the tree rubbed by the caribou was preceded by 4 or 5 days with temperatures from 7 below to 18 below zero, followed by cessation of the extreme cold.

With us in Quebec there had been some cold weather about Christmas. On January 1, it was 20 degrees below, on January 2, minus 28 degrees in the morning and zero in the afternoon. On January 3 the thermometer climbed to plus 20, with 18 on January 4 and 5. Whether there is any connection between low temperatures and the anxiety of the moose and caribou to rid themselves of their horns, I do not know.

On this same trip, at a time when the moose are supposed to be quite placid after the rut is over, I found on the open shore ice of one lake, perhaps half of a peck of moose hair, much of which was attached to skin. There was some fresh blood on the snow and the hair was scattered over an area about 15 yards square. There was so much hair that I noticed it from quite a distance out on the lake, and went to investigate. Had there been but a handful that might have been scraped off by one blow, I would have paid no further attention to it, but it must have taken a number of blows with the front feet to scrape off this amount; yet the tracks gave no indication that the moose were pushing each other around with their horns, as they do when fighting during the rut. I looked for shed horns here but found none, nor could I tell the sex of the moose. There were no tracks other than those of moose.

It has, I believe, been said by at least one authority that moose do not like to travel over ice. Naturally, they will not go on glare ice where they cannot stand up, but my understanding is that they were said to be afraid of ice even when covered with snow. Among woodsmen who know moose I can find no confirmation of this statement. We met two moose at different times at least one-half mile from the shores of lakes. Also, we repeatedly saw tracks where moose had crossed lakes. On two occasions I found tracks crossing bays where it would have been easy for the moose, and but little out of their way, to have followed the shore around the edge of the bay. In these two cases the moose chose the snow-covered ice in preference to following the shore.

In 30 inches of snow, and even through somewhat heavier drifts, the moose apparently were not at all hampered in their movements, and where there were several together they did not even bother to walk in each other's tracks. At this time moose were browsing mostly on poplar, less on balsam and birch, with here and there some pine, but not at all, of course, on spruce.

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THE MARYLAND MUSKRAT MARSHES

By Vernon Bailey

The muskrats were there before Maryland was named, and now they are probably just as numerous, and far more valuable, than they were 300 years ago.

When first settled in 1634, Maryland was rich in natural resources, good timber, rich soil, abundance of fish, oysters, game and fur-bearing animals. With a liberal government under Lord Baltimore, it was rapidly settled and grew into a flourishing colony on friendly terms with the Indians and neighboring colonies. Its extensive shorelines and convenient water ways hastened its development in the pre-railroad and pre-automobile days, and its natural wealth and prosperity are shown in thriving towns, fine old homes, and prosperous farms.

But now the timber is greatly reduced in extent and quality, the soil is not what it used to be, the fishing has been much depleted, game and fur-bearing animals are in most cases relatively few in numbers and some are gone completely. There is one notable exception, however; the muskrats apparently are holding their own fairly well under present management.

The enormous extent of tidal marshes bordering Chesapeake Bay, and most of the smaller bays and rivers of the low country of Maryland, evidently were a paradise for muskrats and waterfowl before the white men came, and for long thereafter, but there is little record of any important use of muskrats in the early days. As long as the beaver, otter and mink were available, their valuable furs were eagerly sought, and they rapidly disappeared as a consequence. Then the less valuable kinds took their place and were drawn upon to supply the fur trade.

Sixty years ago, muskrat skins sold for 5 and 10 cents apiece, but a little money was worth a whole lot in those days. Thirty years ago, muskrat skins were worth 25 cents apiece, and 20 years ago they jumped to $4.50 apiece. Now the best skins of Maryland muskrats, which are the largest, darkest and most valuable of any in the whole world, are worth about $2 apiece. And the annual catch for the state of Maryland is about one million muskrats a year.

The muskrat industry is recognized as one of the important resources of the state, and good muskrat marshes are as valuable as any farm land. In fact, they are a very popular branch of agriculture, as the muskrats take care of themselves and are harvested only in the three winter months when their fur is at its best and there is not much other work to do. Three or four muskrats per acre is about the average yield, but on a good marsh, well managed, 6 or 8 per acre is not an unusual crop. Too many muskrats will exhaust the food, ruin the marsh, and starve to death, while excessive trapping will keep down the breeding stock and reduce the yield below the profit

level. The business requires much practical knowledge and experience, and then the fluctuation of fur prices introduces an unstable element, as in other lines of stock raising. There seems, however, a possibility that improved methods of handling the business may increase the returns, and selection of breeding stock improve the grade of fur. Also, I believe, the present cruel

FIG. 1

FIG. 2

FIG. 1. A Maryland muskrat marsh, with flat-topped muskrat houses characteristic of the Blackwater River region. FIG. 2. One corner of an attic where 12,000 muskrat skins were drying on wire stretchers, March, 1937, two weeks before the end of the trapping season. During the winter 7000 had already been sold from this attic.

method of taking the muskrats in steel traps, with the result that about one-half of them twist off a leg or foot, can be greatly improved.

For several years I have been working on traps for taking muskrats in a manner of which one need not be ashamed, and by the next trapping season I hope to have a sufficient number ready for a thorough trial. One of these

FIG. 3

FIG. 4

FIG. 3. Muskrat in live trap that sets under water and springs as the animal swims against the trigger. The photograph is of a mounted specimen previously caught in this type of trap. FIG. 4. Muskrat caught and killed instantly in "quick killer" type of trap, avoiding suffering, injury, and danger of loss.

is a quick-killer type that breaks the neck or skull and kills the animal instantly. The other is an improved cage trap that will catch and hold an animal comfortably until transferred to a cage or pen.

There is a good demand for live muskrats for stocking marshes that have been unwisely depleted, or for starting new muskrat farms, and the price of live muskrats usually is several times greater than for skins. The main difficulty is the considerable cost of live traps when compared with the cheapest forms of the steel traps in present use, and the moment that this discrepancy is overcome the trappers will be glad to adopt the former. Trappers are no more cruel than other people but often they have no other way of making a living, and generally they become careless and hardened to the sufferings of animals. It is as much our fault as theirs that they have not adopted a better manner of handling fur-bearers. It seems high time to improve the situation, and Mr. Douglass Hayes and I, with the encouragement of Mr. Sanderson of the Humane Association, and other national organizations including the American Trappers Association, are trying to place trapping on a basis as decently humane as any other live stock industry.

Muskrats are interesting animals, with very fixed ideas of their own for which their numerous enemies are largely responsible. While timid and nervous and quick to take alarm, they are just as ready to attack in self-defense, and will fight to a finish with any enemy, large or small, if escape is not feasible. Their large, keen-edged incisors, backed by strength and quickness, are very effective weapons that have left deep scars on the hands of trappers, the noses of dogs and other large enemies, but minks, weasels, coyotes, foxes, raccoons, eagles, large hawks and owls destroy many of them for food. The males sometimes fight among themselves and it is not rare in the breeding season to find an old male so cut and slashed by opponents that his skin is worthless. Also, a muskrat in a steel trap is occasionally found dead, cut to pieces by another that probably tried to help him to escape and was misunderstood, so that a deadly fight ensued. But with friends they are confiding and sociable. The confidence of an old muskrat is not quickly won, but even adults have been tamed and the young make interesting pets.

Muskrats are great builders of houses, but while friendly with beavers and often associated with them, they have never learned to build dams to control the water supply. Their houses too are of a type of architecture all their own. Generally placed in a shallow lake or pond or on a floating marsh, they are erected in conical form 4 or 5 feet high and as broad at the base, without windows but with one, two or three doorways opening beneath into burrows leading off under water. The house walls are made of grass, sods, roots and floating trash, piled around and over the nest chamber and well cemented together with mud and wet earth. Coarse reeds are sometimes used as building material, but rarely sticks or wood. The house walls are often a foot thick and quite solid, surrounding one or two nest chambers large enough to afford sleeping quarters for 2 or 3 to 6 or 8 muskrats. Some small houses are evidently intended for only one or two animals, but they are quickly enlarged if necessary. The only ventilation is through the building material,

but in winter when the walls are frozen hard and snow covers the houses, there are often traces of steam coming from the peak of the houses, and the snow soon melts over the top.

Like the beavers, they often live in bank burrows, extending back 25 or 50 feet from the water and ending in roomy chambers well concealed from above. Sometimes 10, 20 or 30 muskrats have been found in one of these burrows in winter when they were being mercilessly trapped in the marshes, but the practice of disturbing either dens or houses should be discouraged as fatal to the maintenance of a reasonable breeding stock on any muskrat grounds.

Muskrats are dainty feeders and select the choice shoots, rootlets, bulbs and tubers of growing plants, mostly from under tough sods or on the bottoms of lakes and ponds. They dig burrows through the marsh and generally under water in search of the roots of tules, "three square grass", sedges, cattails, reeds and grasses, eating only the tender, starchy shoots and blanched bases. Pondweeds are extensively eaten where they grow in still or running water. Young stems of wild rice are much favored and in places roots and bulbs of sagittaria, rootlets and flowers of water lilies, and a great variety of plant foods over the country at large.

In captivity they are very particular about food, generally refusing all the things offered except apples, sweet potatoes and rolled oats. This, however, seems a satisfactory and wholesome ration on which they thrive, and that is easily provided.

Their food, generally eaten in or at the edge of the water, is clean and fresh and wholesome. No mammals have more exemplary food habits, which to some extent may account for their popularity as food among birds, mammals, and even man. Carefully dressed to avoid a trace of musk, properly cooked and served, their meat is sweet, rich and tender, with the gamy flavor of wild duck. Those sold in the market as marsh rabbit are generally popular food, but often would be much better if more carefully prepared and handled before reaching the consumer. The rough-dressed carcasses bring 10 cents a pound to the trapper, or 15 or 20 cents each in addition to the fur value.

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NOTES ON THE FOOD OF CHINESE HEDGEHOGS

By Ch'eng-chao Liu

Hedgehogs are common and widely distributed in North China. They live in holes, under stones of old walls and houses, and also are frequently found under heaps of straw and grass, accumulated by farmers and allowed to remain undisturbed for years. During the evenings of late spring, summer and autumn, one may often see this animal walking slowly by the side of the road, or elsewhere near all sorts of dirty places. When touched or disturbed by some sound, it will immediately roll up into a ball. It is thus well protected from harm.

Hedgehogs are suspected by farmers of eating cabbage, sweet-melons, watermelons, and jujube "dates". A hedgehog is said by farmers to be able to carry a large number of jujubes to his den by rolling his body over the fruits that have fallen to the ground, so that a number of them become attached to the spines. I was told many times by farmers in different parts of North China that hedgehogs come out at evening and turn over a large number of melons in order to choose the best ones. They also do a lot of damage to vegetables. For this reason, quite a few of them are killed by the farmers in the fields and gardens. On the other hand, the literature presents a different picture regarding the food habits of this animal. Crotch (1850) stated that hedgehogs eat bees. Wood (1860) recounted that the food of the hedgehog consists chiefly of insects, worms, snails and similar creatures. Peacock (1900) mentioned that grapes had been eaten by hedgehogs; and Barrett-Hamilton (1910) recorded that the food of hedgehogs usually consists of worms, slugs, snails, bees, wasps, various insects and other invertebrates, frogs, young birds, mice, rats, and rabbits; acorns, wild fruits, apples and mushrooms.

Curiosity prompted me to investigate the stomach contents of this animal. For this study 47 individuals were collected near Yenching University, Peiping, during the evenings of August, 1935. It is easy to obtain them. One can secure a number of living specimens with a lantern and a large bag by walking around dirty places and near old walls and houses during the evenings, and simply picking them up when they roll up at the disturbance. When brought to the laboratory of the Biology Department of Yenching University, the hedgehogs were immediately killed with ether. The stomach contents were removed and washed with water through a piece of very fine screen. After washing, the contents were preserved for study in 5 per cent formalin.

As the hedgehogs were killed as soon as possible after capture, the stomach contents were in good condition for identification. Maggots of flies were complete and could be counted individually. Other kinds of food were recorded according to frequency in individual hedgehogs. Our meager knowl-

edge and the reports of the farmers regarding the food habits of the hedgehogs are possibly incorrect. From the present study, about 95 per cent of the stomach contents are maggots, 4 per cent are fragments of other animals, and only about 1 per cent is vegetable matter.

STOMACH CONTENTS OF HEDGEHOGS

TYPE OF FOOD	CHRYSOMYIA	MUSCA	ERISTALIS	OTHER INSECT FRAGMENTS	ASCARIS	HAIR	FEATHERS	JUJUBES	OTHER VEGETABLES
Total number of food items	754	330	35	23	14	8	5	5	7
Number of hedgehogs for each type	23	10	4	15	9	3	1	4	7
Percentage	63.88	27.94	2.96	1.94	1.18	.67	.42	.42	.59

The result of this study proves that previous ideas regarding the food of the hedgehogs is not wholly true, as 63.88 per cent of their stomach contents in North China is composed of maggots of *Chrysomyia*. These flies are serious pests of domestic animals and cause sickness and sometimes death. Second in importance are the maggots of *Musca*, comprising 27.94 per cent of the food. The species of *Musca* are not only annoying pests, but often carry germs of typhoid fever, dysentery, and other enteric diseases. Still other maggots eaten by hedgehogs are *Eristalis* of the family Syrphidae, the larva of which is known as the rat-tailed maggot. *Eristalis* species are supposed to be beneficial for pollination, but the percentage eaten is rather low (2.96) in comparison with *Chrysomyia* and *Musca*. The other insect fragments found in the stomachs of the hedgehogs can be identified to a certain extent by their heads, legs and wings. These consist of incomplete fragments of mole-crickets, earwigs, and some Coleoptera. It is interesting to find some complete and incomplete ascaris as one item of the stomach contents of the hedgehogs. A few hairs were found in three stomachs and five feathers in another. Plant food, such as leaves of vegetables and grass, and seeds of sweet-melons, occur with maggots or other animals in the stomachs. Only in one instance had a hedgehog fed solely on jujubes.

The above data suggest that hedgehogs resort to the filthiest places, such as the old-style water-closets in North China. Here they examine manure and decayed animals and vegetables, in search of maggots. In connection with such feeding habits, ascaris, hairs, feathers, seeds, and fragments of vegetables in feces and manure may be taken fortuitously. As mole-crickets and some of the beetles are commonly found in such polluted places, the hedgehogs may obtain some of these animals when maggots are not available. According to Bate (1904), and Barrett-Hamilton (1910), hedgehogs do eat grapes, apples, and other wild fruits. The result of the present study indi-

cates that hedgehogs are beneficial to man, and that they are insectivorous. Of the stomach contents, only 1.01 per cent is of vegetables, insects alone comprisng 96.72 per cent of the total contents. The only explanation that I can offer for the reported damage to melons done by the hedgehogs is that their searching for larvae under the melons is erroneously attributed by the farmers to fondness for the melons themselves. Further field investigations may shed further light on this problem. The result of the present investigation forces the author to conclude that the hedgehogs of North China are largely beneficial. It would seem the better part of wisdom to give full protection to these useful animals.

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A NEW KANGAROO MOUSE (MICRODIPODOPS) OF UTAH AND NEVADA

BY E. RAYMOND HALL AND STEPHEN D. DURRANT

Kangaroo mice, heretofore known from northern and western Nevada and closely adjoining parts of Oregon and California, were unexpectedly taken in 1931 and 1932 in southeastern Nevada, and in 1936 still farther east in Utah, from which state the genus has not previously been recorded. The specimens from Utah and the nearby localities in Nevada are of the pale colored type described from southwestern Nevada under the names *Microdipodops pallidus* Merriam, *Microdipodops megacephalus dickeyi* Goldman, and *Microdipodops megacephalus lucidus* Goldman, but appear to be subspecifically distinct from any of these. The new race may be described as follows:

Microdipodops pallidus albiventer, new subspecies

Type.—Male adult, skull and skin; no. 52,803, Mus. Vert. Zool.; from Desert Valley, 5300 ft., 21 miles west of Panaca, Lincoln County, Nevada; May 30, 1932; collected by W. C. Russell; original no. 2188.

Range.—Known from central Lincoln County, Nevada, and southwestern Millard County, Utah.

Diagnosis.—Size small (see measurements); hind foot not over 25 mm.; general color pale, hair of underparts everywhere white entirely to base, dark color of upperparts near light buff (of Ridgway, Color Standards and Color Nomenclature, 1912), tail lacking

black tip; skull with bullae less inflated than in other pallid forms, nasals short, averaging less than the minimum for *pallidus*, *dickeyi* and *lucidus*.

Comparisons.—Compared with the pallid forms just mentioned, which are the nearest relatives of *albiventer*, the latter is distinguished principally by smaller size, although the color of the upperparts seems to average a trifle lighter.

Measurements.—Sixteen adult topotypes provide average and extreme measurements as follows: Total length, 151 (138–160); length of tail, 80 (72–89); length of hind foot, 24.0 (23.0–25.0); greatest length of skull, 28.1 (27.1–29.2); greatest width across auditory bullae, 18.9 (18.5–19.5); zygomatic breadth at front of bullae, 11.4 (11.0–11.6); length of nasals, 9.6 (9.1–10.4); interorbital breadth, 6.6 (6.3–7.0); alveolar length of maxillary tooth-row, 3.4 (3.1–3.3).

Remarks.—The animals from Utah are mostly in post-juvenal pelage which is darker than the adult pelage of animals taken earlier in the year in Nevada. The five youngest specimens from Utah, really juveniles, however, compare favorably with two of the same age from the type locality.

Without advancing at this time any final ideas about the classification of the named kinds of *Microdipodops*, we suggest *pallidus* rather than *megacephalus* as the specific name proper to use in combination with our subspecific name *albiventer*. We suggest this because animals of the pallid type, and others of the dark type to which the name *Microdipodops megacephalus megacephalus* is applicable, repeatedly have been found within a few feet of one another and always without intergradation in color characters. Employing the criterion of intergradation for subspecies, it would seem improper to use the name *megacephalus*. Populations of animals of the *pallidus* type are widely distributed across southern Nevada and, although of interrupted distribution geographically, show individual if not geographic overlapping in characters, and therefore indicate subspecific rank for *albiventer*.

Type of soil, as previously noted (Jour. Mamm., vol. 10, p. 298, 1929), is important in determining the local distribution of these mice. For the pallid forms, fine sand, or in its absence wind blown silt, together with some plant growth, is required. At the type locality of *albiventer*, strips of hard bare mud flat alternated with bands of whitish gray sand-like silt at the northwestern edge of a dry lake. This drifted soil supported a sparse growth of desert shrubs about 8 inches high, and the mice were taken at this locality only on the drifted soil. In Utah the mice lived on similar wind blown sand-like silt of a dirty white color with a tan cast. Some small stones were mixed with the soil and the dominant shrubs here, on the windward side of the dry lake, were *Eurotia*, *Atriplex* and *Chrysothamnus*. At the other stations of occurrence, designated by reference to Summit Spring and Hancock Pass, the mice occurred on the extensive areas of deep white sand which supported a variety of xerophilous plants. Notable was the occurrence here of *Artemisia tridentata* of the Upper Sonoran Zone and higher zones, side by side with Joshua trees and cholla cactus of the Lower Sonoran Zone. We have never caught *Microdipodops* in a place lower zonally than the upper margin of the Joshua tree belt.

Near Hancock Pass and Summit Spring, 1153 trap-nights yielded 9 *Microdipodops pallidus albiventer*, 119 *Perognathus longimembris panamintinus*, 4 *P. parvus olivaceus*, 5 *Dipodomys merriami merriami*, 18 *D. microps levipes*, 2 *Peromyscus maniculatus sonoriensis*, 1 *P. crinitus stephensi*, 20 *Onychomys torridus longicaudus* and 1 *Neotoma lepida lepida*. It is true that when we trapped here the number of small mammals was at low ebb—evidenced by cobwebs in deserted burrows and wood rat nests, as well as by the small total catch—but the fact that *Microdipodops* comprised only 5 per cent of the mammals trapped was unusual for a sandy area of this type where kangaroo mice occurred at all. In our experience the relative number of kangaroo mice was small also in Pine Valley, Millard County, Utah, where only 16 individuals, together with 72 *Dipodomys*, were taken in 223 trap-nights, and at the type locality, where 560 trap-nights

yielded 24 *Microdipodops* and 39 other rodents. These catches contrast strongly with others on favored soils farther toward the center of the range of the species. Records of 3 of these are as follows: May 27, from 227 traps, 67 *Microdipodops* and 35 other rodents; May 17, from 198 traps, 92 *Microdipodops* and 12 other rodents; July 10, from 313 traps, 121 *Microdipodops* and 35 other rodents.

In review: *Microdipodops pallidus albiventer* was relatively rare in each of the three valleys where found. These places, for this genus, are unusually low in the life zone scale. The stations of occurrence are the southeasternmost recorded for the genus and we judge them to be at or near the actual margin of its geographic range. None was found, although trapped for, on similar soils farther southeast. We suggest that the relative scarcity, and conceivably the small size of the individuals, at these marginal localities is caused by the inhospitable environmental factors, whatever they may be, which limit the geographic range of the genus in this direction.

Specimens examined.—Total number, 47, as follows: **Nevada,** *Lincoln County:* 8 mi. N. Summit Spring, 3; Desert Valley, 4700 ft., 5.5 mi. N. Summit Spring, 3; Desert Valley, 8 mi. S. W. Hancock Summit, 5200 to 5300 ft., 3; Desert Valley (distinct from valley of same name previously indicated), 5300 ft., 21 mi. W. Panaca, 22. **Utah.** *Millard County:* Pine Valley, 0.5 mi. E. of headquarters building of the Desert Experiment Station of the United States Forest Service, which buildings are located in Section 33, Township 25S, Range 17W, Salt Lake Base Meridian, 16.

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GENERAL NOTES

DELETERIOUS EFFECTS OF PRESERVATIVES ON STUDY SPECIMENS OF MAMMALS

Mr. James L. Clark's article in the February number of the JOURNAL OF MAMMALOGY (1937), entitled "The Preservation of Mammal Skins in the Field," should bring realization to all collectors of the need for thoroughly degreasing skins before stuffing them, and of the need for the employment of some one of the more effective methods to guard against decay ("slipping") of the animals to be prepared as specimens. Anyone who works with a large mammal collection soon finds examples of wasted effort—specimens scientifically valuable, sometimes priceless, rendered useless by "grease burning," putrefaction of the animal tissue before the skin was "cured," or by other causes often preventable in the early stages of preparation. Preparators with the extensive experience of Mr. Clark, in both field and shop, probably have fullest appreciation of these defects and their suggestions for improvement are welcomed by the experienced and inexperienced alike.

With study skins of small mammals, the preparator's principal objective is symmetrical, firm, lasting units, in quantity, but the research student's principal objective is the determination of differences and likenesses in color; faintest tints, shades and tones are intensively appraised and form a prime basis for many of his conclusions. Here is where the question arises as to the salt-alum treatment recommended by Mr. Clark (see also description of essentially the same method, but recommending a different proportion of salt and alum, by Cantwell, Jour. Mamm., vol. 11, p. 324, 1930). Undeniably helpful to the preparator in obtaining his objective, it sometimes defeats the best efforts of the research worker to obtain his. When these chemicals change the color of hair the result is irreparable damage, or worse if wrong inference and conclusions follow failure to appreciate the cause of the "new" color. The unequal redness of two skins of the same

species, caused, unknown to the investigator, by a few weeks immersion of one in a jar of chemicals, seemingly throws the laws of geographic variation into disorder and confusion.

Compared with skins prepared in the conventional manner, some salt-alum-bathed chipmunks (*Eutamias*) of which I know have a ground color changed from gray to brown and red stripes in place of black. Kangaroo rats (*Dipodomys*), once whitish, are now fawn colored; black bears are cinnamon bears and mule deer answer best to the description of burro deer! I would not even affirm that a leopard so treated still would be known by his spots. Will salt alone effect some of these alterations? Admittedly it will. "The mixture of salt and alum was wrong or the color wouldn't have changed," one preparator told me. Yes, that is a danger too. But the color of halved skins, one-half treated in the *correct* salt-alum mixture and the other half merely dried, did not always come out exactly the same. That the colors of some kinds of mammals are changed more than those of some other kinds is to me an added objection. May not those with colors changed so little as to be almost undetectable, offer the greatest chance for wrong conclusions? What of the effects in future years? Will immersion now in salt-alum solution cause fading, alteration of pigment, or color change due to chemical or structural alteration of the cortex of the hair, apparent 20 years hence? I do not know, but I am skeptical of all skins so treated.

The least that should be done for study skins subjected to the salt-alum treatment, or to *any* treatment offering fair likelihood of resultant color change, it seems to me, is to label them, preferably at the time of preparation, in a way that will clearly indicate departures from the conventional technique. Knowledge of the lack of this indication on small mammals so treated at once places a suspicion, perhaps not unwarranted, on the scientific competency of the curators of a collection, and earns disrepute for both the institution and the collector.

Truly the object in preparing study skins is to provide opportunity to study them and to seek out truth, rather than opportunity to effect absolute symmetry in preparation. Even so, I confess to a genuine personal gratification derived from the contemplation of one of my mammal specimens if well prepared, firmly made, and indelibly and accurately labeled. At such moments I have even considered the possibility that one or another of several particularly well-stuffed mice a century hence would be as deservedly spoken of and achieve more of favorable remembrance for me than some other accomplishment at the moment better appreciated by my associates. All imaginative people, even including mammalogists, I have heard, aspire to a certain measure of immortality. If this be true, I am fearful for the complexion of the immortality attained by those who use the salt-alum lotion on their skins, for, on the tongues of curators, the bad preparators live almost as long as the good. By one single stroke they risk defeat of both their immediate objective of contributing to the fund of truth and that often more delicately mentioned one of posterity's approbation.

In summary: On the salt-alum method of preserving small mammal skins in the field, I would add to G. G. Goodwin's reservations and A. H. Howell's caution (Journ. Mamm., vol. 18, pp. 92, 95, 1937) concerning it, an outright warning that this method is dangerous. Indeed I recommend *against* employing it even at a sacrifice in quantity, because the scientific worth of skins so treated is impaired.—E. Raymond Hall, *Museum of Vertebrate Zoology, Berkeley, California.*

MAMMAL REMAINS FROM DETRITUS OF RAPTORIAL BIRDS IN CALIFORNIA

Study of the litter of detrital material found near the nests and roosting-places of raptorial birds often provides records of rare species of mammals. Such was the case on March 7 and 8, 1937, when O. P. Silliman, R. L. Rudd, and the writer located an

obvious roosting-place of an owl on a hillside in northern San Benito County, California, 3.5 miles west of San Juan Bautista. Indications are that the species of owl concerned was the barn owl (*Tyto alba pratincola*), but this is not certainly known. The site which the owl had chosen as the base for its operations was the nest of a pair of golden eagles (*Aquila chrysaëtos canadensis*), located some 60 odd feet above the ground on the north face of a huge boulder approximately 140 feet high. The nest was unoccupied at the time of our visit. At the base of the boulder below the nest, however, there was a considerable amount of the skeletal remains of vertebrates, most of it contained in owl pellets, with the remainder consisting of scattered osseous elements.

A large part of this detritus was gathered together and brought to the Museum of Vertebrate Zoology for examination. Some of it was quite old, as evidenced by the amount of weathering that had taken place, while considerably more than half of it was comparatively fresh. Bone materials (chiefly skulls and fragments of skulls) were found of 15 species of 4 separate orders of mammals, of 2 species of birds, and of 2 species of reptiles, giving a total of 213 individuals as follows:

MAMMALS

Neurotrichus gibbsii hyacinthinus, 2
Sorex trowbridgii montereyensis, 1
Sorex ornatus californicus, 1
Spilogale gracilis phenax, 1
Citellus beecheyi beecheyi, 2
Thomomys bottae bottae, 58
Perognathus californicus californicus, 3
Reithrodontomys megalotis longicaudus, 9
Peromyscus californicus benitoensis, 6
Peromyscus maniculatus gambelii, 21
Neotoma fuscipes annectens, 1
Microtus californicus californicus, 101
Lepus californicus californicus, 1
Sylvilagus audubonii audubonii, 1
Sylvilagus bachmani bachmani, 1

BIRDS

Gallus domesticus, 1
Aëronautes saxatalis saxatalis, 1

REPTILES

Pituophis catenifer catenifer, 1
Thamnophis ordinoides atratus, 1

The two specimens of shrew-moles from owl pellets in this collection are the first recorded from San Benito County, and there is only one more southern record of occurrence. This is from Fremont Peak, Gabilan Mountains, Monterey County, 9 miles southeast of the present locality. The two specimens of shrews are also the first recorded for that county. The remaining forms of mammals are present in this region in about the proportions listed.

The skunk, ground squirrels, rabbits, and snakes were obviously animals that had fallen prey to the eagles. This was determined on three counts: first, on the basis of size of the various forms; second, diurnal habits of all save the skunk (probably captured at dusk or in the early morning); and third, the fact that none of the skeletal elements representing these forms were found in owl pellets.

With the exception of the white-throated swift, the remaining species (all mammals) were definitely found in owl pellets, or in the midst of debris that had evidently formerly been pellets but had become largely disorganized from weathering.—Jack C. von Bloeker, Jr., *Museum of Vertebrate Zoology, Berkeley, California.*

LICE ON HIBERNATING AND NON-HIBERNATING MAMMALS

Lice, both sucking and biting, are found only on homoiothermic hosts. All experimental work indicates that while the parasites can stand low temperatures for a short

time, in order to maintain themselves and reproduce they require a temperature close to that found on their normal, active hosts. Either biting or sucking lice have been reported from all major orders of mammals with the exception of the Chiroptera.

The absence of lice of any kind on the Chiroptera may be due to the temperature factor alone, since in hibernating bats the temperature drops to approximately that of the surrounding atmosphere. With this temperature factor in mind, the study of the parasites of other hibernating mammals becomes extremely important. Unfortunately, but little is known concerning hibernation in American mammals and the term itself is loosely used. Hibernation to some means a definite drop in body temperature with the mammal becoming torpid, while to others it denotes merely a denning-up of the animal without any regard to a lowering of the body temperature or to the state of the animal. Other than bats, the woodchuck and the ground squirrel are the only American mammals studied that periodically become torpid with greatly lowered body temperature. No lice, sucking or biting, have ever been reported from a woodchuck. Only sucking lice have been reported from ground squirrels in regions where they hibernate. An interpretation of this latter case raises the following questions. Do the ground squirrels with lice, under natural conditions, undergo a drop in temperature as under experimental laboratory conditions? Is the drop in temperature under natural conditions of sufficiently short duration for the lice to survive? Does the louse pass the winter in an egg stage? Do these lice differ from the others studied in that they do not require a constant temperature to maintain the species?

Little is known concerning the body temperatures during the hibernation of porcupines, raccoons, skunks and badgers. There is much to indicate that their so-called hibernation is merely a denning-up during unfavorable weather. Lice have been reported from all of the above mentioned hosts, collected in regions where they are said to hibernate.

Host records of the lice of mammals show many peculiarities. Domestic dogs and cats are near relatives phylogenetically and generally show a fauna of identical or closely related parasites. The dog has a species of sucking louse and possibly two species of biting lice peculiar to it. On the other hand, the domestic cat is parasitized only by a species of biting louse. Nothing is known of the subject that would render predictable the absence of sucking lice on cats. It is of further interest to note that no sucking lice have been reported from wild felines, although biting lice have been reported from them. Students are in general agreement that parasites and hosts have evolved together, thus explaining why one can predict, within limits, the host or host family from which a particular louse was taken. The absence of biting or sucking lice on a particular group of wild mammals is not at present explainable, and collections of lice from wild hosts have not been sufficiently numerous to warrant the conclusion that biting lice, or sucking lice, or both are absent from any definite group of wild mammals with the exception of the Chiroptera.

It is the hope of the writer that those having the opportunity will appreciate that the collecting of ectoparasites contributes much not only to entomology but also to our knowledge of mammals. Biting and sucking lice are easily collected by combing with a fine-toothed comb, or by wrapping the dead animal or the drying skin in cotton for 24 to 48 hours following death. The lice will crawl on the cotton, become entangled in it and die. For the sake of accuracy in host records, dead animals should not be allowed to come in contact with each other, as lice tend to migrate after the death of the host.—F. H. Wilson, *Department of Zoology, Tulane University, New Orleans, Louisiana.*

PIGMY SHREW IN NEW HAMPSHIRE

On August 27, 1936, A. E. Preble and I were encamped on Metallak Point, at the First Connecticut Lake, 7 miles northeast of Pittsburg, Coos County, New Hampshire.

This is at an altitude of 1600 feet, in the Canadian Zone. Our traps were set along the margin of a partially submerged area of land which bore evidence of being inundated whenever the level of the lake was raised. Such conditions are known as "dry kye" to the backwoodsman. At the margin are sphagnum moss and tall grass.

In one of our traps was a specimen of *Microsorex*. I have been unable to find any previous records of this genus having been taken in the state. The present specimen is referred to *Microsorex hoyi thompsoni* (Baird).—N. A. PREBLE, *73 Prospect Street, Wakefield, Massachusetts.*

MIGRATION OF LITTLE BROWN BATS

Early on the morning of October 29, 1936, hundreds of little brown bats, *Myotis lucifugus lucifugus*, were found dead or dying on the streets of Black River Falls, Wisconsin. Some of these were found clinging to the sides of buildings, awnings, and store fronts. Undoubtedly they had become exhausted after a long flight during the night. Several specimens were dissected and were found to be fat and in good condition, which suggests that they were migrating to a warmer climate. It is not unlikely that a sudden cold wave, in the northern portion of the state, was the impetus for this migration.—FRED R. ZIMMERMAN, *Black River Falls, Wisconsin.*

NOTES ON FOSSIL MUSTELIDS FROM THE UPPER PLIOCENE OF IDAHO AND TEXAS

Early in 1934 I described (Jour. Mamm., vol. 15, pp. 137–149, 1934) some new species of fossil mustelids from the upper Pliocene deposits near Hagerman, Idaho, two of which were tentatively referred to the genus *Lutravus* Furlong (Carnegie Inst. Washington, Publ. no. 418, pp. 93–103, 1932). These were based on lower jaws, the upper teeth being unknown. Additional mustelid material from the Hagerman beds, collected during the summer of 1934, includes two upper carnassials, not associated with lower jaws, apparently representing the larger species, *Lutravus? idahoensis*. The upper carnassials, if correctly referred, show that the Idaho species do not represent *Lutravus*. P^4 does not exhibit the large, posteriorly placed deuterocone characterizing this tooth in *Lutravus halli* Furlong from the Thousand Creek Pliocene, but shows a comparatively small, antero-medially directed spur with a small, but distinct, deuterocone. These teeth approach more closely those in *Martes*, but without the marked indentation of the lingual margin of the tooth posterior to the deuterocone. A cingulum extends posteriorly from the deuterocone in nearly a straight line as seen from below, and shows a slight tetartocone in medial view. The rudimentary tetartocone, however, is less conspicuous than in *Grisonella*.

Coincident with the finding of upper teeth of this Idaho mustelid, I was able, through the kindness of R. A. Stirton, University of California, to examine the type of *Canimartes cumminsii* Cope from the Blanco formation, which he had borrowed from the University of Texas. Inspection of this material has apparently confirmed a doubt as to the position which Cope assigned to one of the tooth fragments. The small tooth portion which Cope described (4th Ann. Rept. (1892), Geol. Surv. Texas, p. 52, pl. 14, figs. 12–14, 1893) and figured as the talonid of P_4, is apparently the deuterocone portion of the upper carnassial, belonging not to the preserved P^4, which incidentally lacks the deuterocone, but to the corresponding tooth from the opposite side.

Recognition of the identity of this small tooth portion greatly alters our conception of the genus *Canimartes*, and removes the principal difficulties which were earlier encountered in attempting to refer the smaller Idaho mustelids to this genus. Allocation of the two species to *Canimartes* is made tentatively, inasmuch as the characters of the premolars and the dental formula of the genotype, *Canimartes cumminsii*, are not known.

Of the two forms, *Canimartes? idahoensis* and *Canimartes? cookii*, the larger *C.?*

idahoensis approaches most closely in size the species *C. cumminsii*. The lower carnassial of *C. cumminsii*, however, is narrower and has a smaller and somewhat less distinctly basined talonid.—C. LEWIS GAZIN, *U. S. National Museum, Washington, D. C.*

ACTIVITIES OF A WEASEL AT A WOODRAT COLONY

The incident here reported occurred during the last week of April, 1936, in the hills 4 miles north of Berkeley, in Contra Costa County, California. It concerned dusky-footed woodrats (*Neotoma fuscipes annectens*), a weasel (*Mustela frenata nigriauris*) which visited the woodrat colony, and several other mammalian inhabitants of the vicinity. I first saw the weasel at 9:05 A.M., on April 27, when I was examining a woodrat house where I had heard the chatter of a woodrat late the previous afternoon. The weasel moved slowly but easily about the house within 4 feet of me. When on a level with my head it stopped, and with small, beady eyes fixed upon me, tested the air with its nose. It was comparatively bold and seemed unafraid. After a minute, it retreated, and I heard it moving within the house. Half an hour later I heard a low staccato call of six syllables, *hith—hith—bu-bu-bu-bu;* the first two long lisping hisses, the others short and mumbling. This was followed by sounds as of bones being cracked and crunched. When I made a slight disturbance, a woodrat chattered high in the house.

I left at noon and returned at 8:30 A.M. on April 29, after a rain. A faintly musky odor about the house was the only trace of weasel detected; it was not seen again. This house was not disturbed, but in another one 40 feet away a thorough examination revealed a single young woodrat, apparently an orphan. On the morning of May 2, at a point 600 yards from the woodrat colony, a dead brush rabbit (*Sylvilagus bachmani ubericolor*) was found in a small clearing. It had been bitten through the neck at the base of the skull, apparently by a weasel. The flesh was white from loss of blood. Fur, lying about in small tufts, had been plucked from the hind quarters, the thorax, and the left fore quarter. The killer had opened the thorax and abdomen, and removed the heart and lungs. Apparently the liver had been eaten, only bits of it remaining. Other viscera were strewn about the carcass.

The next day, when I opened the woodrat house where the weasel had been seen, freshly cut leaves of gamble weed indicated the presence of a woodrat. Many flies were noticed. Scant remains of two woodrats, a half-grown one and an adult, were found. Some pieces of these animals had been picked up and stored by another rat. Absence of spattered blood indicated quick kills or transport of the victims to the place after killing. When the structure was further disturbed an adult female woodrat ran out and climbed into a near-by live oak. After chattering shrilly, it returned to the far side of the house, where it produced an alarm clatter by beating its tail on the structure. The animal then proceeded to a chamber in the top of the house where there were fresh cuttings of elderberry and gamble weed, and stored seeds of poison oak.

Another chamber contained a nest somewhat disarranged and other evidence of presence of the weasel, including the two hind feet, some viscera, and bits of fur of an adult woodrat, the tail of a very young woodrat, and pieces of a mouse (*Peromyscus californicus parasiticus*).

These observations seem to show that the weasel had carried the carcass of an adult woodrat to the base of the house on April 26, and had killed the young woodrats and the mouse that night or the next morning. My visit on the morning of April 27 apparently frightened away the animal. The adult female woodrat survived this invasion, but at least 4 animals had been eaten at this house. Possibly the rabbit found in the vicinity had been killed by the same animal.—ELDEN H. VESTAL, *Museum of Vertebrate Zoology, Berkeley, California.*

PREY OF WEASEL AND MINK

From the Forest Service lookout on Spanish Peak, a road winds steeply downward to the highway between Bucks and Quincy, the county seat of Plumas County, California. The south slope of Spanish Peak, formerly timbered, was devastated by fire in recent years, but has since become covered with a dense growth of chinquapin (*Castanopsis sempervirens*) and spiny snow-brush (*Ceanothus cordulatus*).

On August 18, 1934, at about 2 P.M., as I was driving along this highway toward Quincy, slightly less than one-half mile past the steep road to the lookout and in the midst of this area of heavy underbrush, my attention was attracted by two small animals struggling in the dust beside the roadway ahead. As I approached, I could see that one was a weasel (presumably *Mustela frenata nevadensis*) that had set upon a Sierra golden-mantled ground squirrel (*Callospermophilus chrysodeirus chrysodeirus*). The weasel had seized the squirrel by the lower jaw near the throat but could by no means hold its victim down, and the two contestants wrestled over an area several feet in extent.

They paid no attention as my automobile drew to a stop within three feet of them, but when I stepped out to view the contest to better advantage, the weasel instantly released the squirrel and disappeared under a chinquapin bush. The squirrel thereupon promptly sought to make its escape, and scurried across an opening in the underbrush at a right angle to the direction taken by the weasel. Before it had gone more than 15 feet, however, the weasel reappeared, and then disappeared in hot pursuit of its quarry.

I was reminded of an incident of several years before, while I was walking, one blazing summer day, along the Western Pacific railroad tracks between Virgilia and Twain, in this same county. There the railroad grade runs parallel to the East Branch of the North Fork of Feather River, at no great distance from its waters. On this occasion I had suddenly heard a shrill squealing and on the railroad embankment some distance ahead, had caught sight of what I took to be two squirrels fighting. They disappeared over the top of the embankment and as I ran up and peered over, I recognized a Pacific mink (*Mustela vison energumenos*) as it slipped under a rock after releasing its hold on a dead ground squirrel (*Citellus beecheyi* subsp.). The squirrel slid limply down the slope and came to rest about 3 feet from the rock under which the mink had disappeared. After about one minute the mink cautiously emerged from beneath its rock, and although I was standing in full view, reached down, seized the nape of the squirrel in its jaws, and drew the dead animal back under the rock.

The East Branch then, as now, contained few trout, its principal fishes being the Sacramento "pike" (*Ptychocheilus grandis*), the hardhead (*Mylopharodon conocephalus*), and the Sacramento sucker (*Catostomus occidentalis*), but these 3 species were then present in considerable abundance in its warm waters, and I thought it noteworthy that the mink should desert this easy prey to stalk a ground squirrel upon the sweltering hillside.—W. I. Follett, *Central Bank Building, Oakland, California.*

SKUNK MORTALITY ON THE HIGHWAY

During a trip by automobile in the summer of 1936, from New York to Cape Breton, Nova Scotia, and return via Quebec, we were interested in counting the dead skunks (*Mephitis*) on the highway. The total count in Connecticut, Massachusetts, Vermont, New Brunswick and Quebec was 20. None were noticed west of New Haven, east of Lowell, Massachusetts, or crossing the State of Maine eastbound by the shore road and north through Bangor; none east of Sussex, or north of Woodstock, New Brunswick, or Richmond on the St. Francis River, Quebec. This leaves some 705 miles of road for the 20 dead skunks, or 1 per 35.25 miles.

The highest concentration was eastbound on July 25, when there were 13 skunks over 132 miles from east of New Haven to west of Lowell, or 1 per 10.15 miles. Returning August 10 from south of Richmond, Quebec, via Sherbrooke, the Rock Island-Derby line, St. Johnsbury and Wells River to Bradford, Vermont, 4 dead skunks were counted over 141 miles, or 1 per 35.25 miles. There remain only 3 skunks, one 15 miles south of Woodstock and one 13 miles west of Sussex, New Brunswick, July 26, and one 7 miles north of Meriden, Connecticut, August 10. To the north and east we were presumably getting out of the animal's range of abundance; to the south and west its numbers along the highroad were too reduced, or those killed were too quickly obliterated by traffic to be noticed.

Figures of dead skunks on the highways are of interest as an index of their comparative abundance, and raise the question whether or not, how and how long, the species will be able to withstand this considerable and unnatural mortality. Other such figures have recently been published. Stoner (Wilson Bull., vol. 48, p. 277, 1936) listed 50 dead skunks for 1905 miles in Ontario, Illinois, Indiana, Iowa, New York, and Ohio combined (1 per 38.1 miles), with a concentration in New York State of 28 for 400 miles (1 per 14.29 miles). Wilford and Wilford (Science, p. 421, Nov. 6, 1936) listed 22 for some 600 miles in New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia and West Virginia (1 per 27.27 miles). The figures are rather comparable over the whole territory.—J. T. Nichols and H. C. Raven, *American Museum of Natural History, New York City.*

LATE SUMMER AND EARLY FALL FOODS OF THE RED FOX IN CENTRAL MASSACHUSETTS

The part of the Harvard Forest at Petersham, Massachusetts, and surrounding property in which fox droppings were collected, contains a great variety of cover types. It has developed mainly from the gradual abandonment and reversion of fields and pastures to forests. Most of the area grew up to white pine in pure stands, much of which has now been cut, and has been followed by hardwoods. Some pastures are seeded in with hardwoods or pine-hardwood mixtures. The result is that nearly all stages of successional development are represented, mainly as small types. There are still some cultivated areas, hayfields and brushy fields, as well as a spruce swamp, numerous hardwood swamps, and approximately 100 acres of coniferous plantations.

Most of the scats were picked up along the numerous roads and paths. A few were found around dens and others in the open woods.

During the period of collection, the ruffed grouse cycle was at a low point in this locality, but there was still approximately one bird to 25 acres. No pheasants were known to be present. Cottontail rabbits were in numbers fair for this region, but sparse compared with those of the agricultural sections of New York or of the midwest. Snowshoe hares also were fairly numerous, but it is doubtful if there was more than one to 50 acres of woodland. Red squirrels were abundant, and gray squirrels less numerous. Woodchucks were rather scarce, since there are few fields in the area and these do not offer abundant food for woodchucks.

The droppings of red foxes were collected from the middle of August to early October. All specimens were relatively fresh (estimated from one to three weeks old) and afford a good indication of the mid-summer dietary habits of foxes in the Harvard Forest.

Examination of 131 scats indicates a pronounced vegetative diet during this period. Of the total examined, 86 per cent contained fruit, in the order of frequency of their occurrence, *Prunus*, probably *P. serotina*, blackberries, *Vaccinium*, *Aralia nudicaulis*, *Vitis* and apple. Insects, chiefly grasshoppers (*Melanoplus femur-rubrum*), were second in frequency, appearing in 53 per cent of the scats. Mammals (cottontails, field mice, shrews, deer mice, squirrels, woodchuck and a mole) were identified in 30 per cent of the

droppings. Bird remains (one, possibly two grouse, one bluejay, one domestic fowl and one an undetermined fringillid) were found in 5 droppings.

One lot of 36 scats, collected chiefly on November 21 and 22, 1936, are a few days to three weeks old, although several are palpably older. These are indicative of the feeding trends of the foxes during the fall.

TABLE I

MID-SUMMER FOOD OF THE RED FOX IN THE HARVARD FOREST, AS INDICATED BY 131 SCATS

FOOD	NO. TIMES OCCURRING	PER CENT OCCURRENCE
Cherries (principally *Prunus serotina*)	71	54.2
Insects (grasshoppers and beetles)	69	52.7
Blackberries	45	34.4
Blueberries	19	14.5
Cottontails	15	11.5
Field mice	12	9.1
Birds	5	3.8
Grapes	4	3.0
Shrews (*Blarina*)	4	3.0
Wild sarsaparilla (*Aralia nudicaulis*)	4	3.0
Deer mice	4	3.0
Woodchucks	2	1.5
Gray squirrels	2	1.5
Wool	2	1.5
Red squirrel	1	.75
Chipmunk	1	.75
Mole (*Parascalops*)	1	.75
Undetermined mammals	1	.75
Apple	1	.75
Extraneous (sand and dirt)	4	3.0

TABLE II

FALL FOOD OF THE RED FOX IN THE HARVARD FOREST, AS INDICATED BY 36 SCATS

FOOD	NO. TIMES OCCURRING	PER CENT OCCURRENCE
Fruits	20	55.5
Mammals	18	50.0
Insects	9	25.0
Birds	2	5.5
Snakes	1	2.7
Grasses	1	2.7

In the fall collection, fruits are represented, in order of their frequency, by apples, wild cherries, grapes, sarsaparilla and service berries. Mammal remains are chiefly of field mice and cottontails, while deer mice and woodchucks each are represented once. Poultry and grouse are represented in a single scat, while another contained the belly plates of a garter snake.—W. J. Hamilton, Jr., N. W. Hosley and A. E. MacGregor, *Cornell University Ithaca, New York, and Harvard Forest, Petersham, Massachusetts.*

SOME EFFECTS OF ALTITUDE AND LATITUDE ON THE COLUMBIAN GROUND SQUIRREL

In 1933, while I was conducting studies of the effect of altitude upon the action of strychnine used in controlling the Columbian ground squirrel (*Citellus c. columbianus*), other interesting elevation data were obtained. Latitude changes also seemed to be a factor.

The usual appearance of young in the vicinity of Pullman, Washington, as shown by Shaw (Jour. Mamm., vol. 6, pp. 106–113, 1925), is about May 10. At Moiese, Montana, at approximately the same elevation, 3 years of observations showed that the young appear about May 25. The difference of one degree of latitude between the two localities apparently causes a difference of 2 weeks in the surface appearance of young.

In the vicinity of Lewiston, Idaho, at an elevation of about 1000 feet, the young appear about May 5. At the Black Pine mine, near Philipsburg, Montana, elevation 6500 feet, it was estimated that the approximate appearance of the young upon the surface would be July 1. Both localities are in the same degree of latitude. Accordingly an increase of 5500 feet in elevation delays the appearance of young approximately 55 days, or one day for each 100 feet.

Colonies at elevations of 6500 and 7500 feet presented a bizarre appearance when viewed early in the season because of the great number of squirrels in juvenal pelage, seemingly out of place at that season of the year.

At 6500 feet elevation, 25 of the 40 females examined were barren; 16 of these were yearlings. Of those rearing young, all were 2 years of age or older. At this time, June 6 and 7, some were carrying unborn young.

At 2600 feet elevation, there were indications on May 17 that practically all the young had been born 3 weeks before. Of the 12 barren females taken at this elevation, but 3 were yearlings.

It seems that high elevations do not afford sufficient time for the young of the current season to become sexually mature. The recording of the sexual maturity of the males was impossible, as but an occasional male was sexually active.

BREEDING AND WEIGHT RECORDS OBTAINED AT FIVE ELEVATIONS IN MONTANA DURING YEAR 1933

Elevation	2,600 feet	3,600 feet	4,500 feet	5,500 feet	6,500 feet	
Nearest Postoffice	Moiese	Moiese	Hall	Hall	Philipsburg	
Dates	May 17–22	May 23–25	May 28–30	June 1–3	June 6–7	Averages
Breeding data:						
♀♀ examined	56	57	45	64	40	
Av. no. embryos or uterine scars	4.9	4.4	5.4	4.3	4.3	4.7
Norm	5	4	5	4	5	
Range in number	2–9	2–8	3–8	3–6	3–6	
% ♀♀ barren	21.0	12.0	6.6	51.6	62.5	
Av. weight barren ♀♀	425.1	410.6	450	355.5	363	401.0
Weight data:						
No. of ♂♂	54	54	32	60	40	
Av. weight	514.6	472.5	530.4	440.3	422.6	476.5
No. of ♀♀	61	59	44	66	45	
Av. weight	474.2	447.9	477.9	397.2	391.5	437.7
Total number	115	113	76	126	85	
Av. weight	493.2	459.6	499.9	410.6	406.1	454.3

The accompanying table indicates that there may be an optimum elevation for the development of this ground squirrel. At 4500 feet occurred the lowest percentage of barren adult females, the largest litters, and the largest squirrels. It is to be expected that the optimum elevation decreases with an increase in latitude. The expected surface appearance of young at this 4500 foot elevation was placed at June 10.

This elevation study in relation to the Columbian ground squirrel may be extended to embrace elevations of 1500 and 7500 feet. The lower elevation is represented by localities near Lewiston, Idaho, although unmolested areas are difficult to find. The higher elevation exists in the vicinity of Philipsburg, Montana, with the possibility that this might be extended to even 8500 feet.—A. W. Moore, *Biological Survey, Hillsboro, Oregon.*

LAGURUS IN SOUTHWESTERN UTAH

A considerable extension of the known range of *Lagurus curtatus pauperrimus* is furnished by 3 specimens that I collected in Bryce Canyon National Park on October 11, 1934, and October 22 and 23, 1936. Their identities have recently been established through the kindness of E. Raymond Hall, who compared them with the series in the Museum of Vertebrate Zoology. I believe this is the first record of *Lagurus* in Utah south of the Uinta Mountains.

The specimens were all taken at 7950 feet altitude in a dry, open swale flanked by yellow pine forest. The swale slopes very gently to the north, providing just enough drainage to prevent it from being a meadow, and is sparsely covered with low brush (*Purshia, Artemisia, Chrysothamnus*) about one foot high, and various annuals. The holes and indistinct runways of *Lagurus* were confined to an area of approximately 4 square rods, in loose clay loam, but fresh droppings and plant cuttings were found over only about 20 per cent of the surface workings in 1934, and in 35 or 40 per cent in 1936. Three seeds of *Pinus ponderosa* were in the mouth of one of the mice when collected. This one was taken in the daytime, the other two at night.—C. C. Presnall, *Zion National Park, Utah.*

NAPAEOZAPUS IN EASTERN MANITOBA

On May 24, 1935, an example of *Napaeozapus* was secured in the Whiteshell Forest Reserve, near Caddy Lake, eastern Manitoba. Although 60 traps were set for two nights in this locality, but one specimen was taken, which probably indicates comparative rarity. It was secured in a very rocky and shrubby habitat bordering a small rapid creek in Pre-Cambrian territory well within the Canadian Zone. Characteristic vegetation here is white spruce, balsam, birch, aspen poplar and various willows, with Banksian pine on some of the higher ground and black spruce, sphagnum moss, and Labrador tea in alternating depressions where muskeg is common.

The male, number 3480 (measuring 241 × 151 × 31.5), was submitted to Dr. R. M. Anderson, National Museum of Canada, for determination, with the result that it was identified as *Napaeozapus insignis frutectanus* Jackson. So far as can be ascertained, this is apparently the first record of this or any member of the genus in the Province of Manitoba. In consequence, its known range is considerably extended to the northwest of that previously ascribed, which is given by Anthony (Field Book of North American Mammals, 1928) as "Found in Oneida and Oconto counties, Wisconsin."—J. Dewey Soper, *National Parks Bureau, Department of Mines and Resources, Winnipeg, Manitoba.*

GEOCAPROMYS REMAINS FROM EXUMA ISLAND

Through the kind interest of Mrs. Vivienne D. Knowles, the Museum of Comparative Zoölogy has lately received a large quantity of bones recovered from a cave deposit on Exuma Island, Bahamas. With but few exceptions they represent a short-tailed hutia which is apparently identical with the form described by Miss Barbara Lawrence from

Crooked Island as *Geocapromys ingrahami irrectus*. Associated with them are a few bones of birds, reptiles, and frogs. Their age is uncertain, but since there is no sign of artifacts or fire, nor of the introduced house rats, they may safely be regarded as pre-Columbian, and perhaps antedate human occupation. Of the hutia bones there are literally hundreds representing all ages and sizes from very young individuals to mature adults. Limb bones are the most numerous, especially femora, as well as many mandibles and fewer palates, but they are often broken, while of crania, only some half dozen show more or less of the middle portion intact. This discovery makes possible a more detailed comparison between the living *G. ingrahami* of Plana Keys and other forms. The anteriormost of the lower cheek teeth is characterized in this genus by the presence of a small inner enamel loop just back of the tip, lacking in *Capromys*. Succeeding this there are two deeper reentrant angles, the anterior of which is never so deep as to meet the opposite enamel wall in *G. ingrahami* nor in *G. i. irrectus*, whereas in the extinct *G. columbianus* of Cuba, in the living *G. browni* of Jamaica, and in *G. thoracatus* of Swan Island, this reentrant angle does extend across to the opposite enamel wall, completely closing off the triangular space at the anterior end of the tooth. In the three lower molars, the two reentrants of the inner side are relatively shorter and straighter in *G. ingrahami*, in m_1 barely reaching the central line of the tooth, whereas in *G. i. irrectus* they extend beyond that axis, and in m_2 and m_3 the anterior one nearly reaches the opposite enamel wall, with its tip curving posteriorly finger-like. Thus the Bahama group may be readily separated from those of the other Antilles. In the Exuma skulls the postorbital process is hardly more than an overhanging ridge or a minute blunt projection, instead of a distinct pointed process as in *G. ingrahami*. Another important point in which the Bahaman skulls agree, and differ from those of *G. browni* and *G. thoracatus*, is in the relative height of the audital bullae. On viewing the skulls from behind, with the palatal aspect uppermost, the bullae are seen to rise considerably beyond the level of the basioccipital bone in the two Bahaman forms, whereas in both *G. browni* and *G. thoracatus* they do not exceed the level of that bone.

The Exuma remains indicate an animal that attained a larger size than the living *G. ingrahami* of Plana Keys and was only a trifle inferior to *G. browni*. A few of the maximum measurements of its limb bones and cranium follow: Humerus, 50 mm.; radius, 41.5; femur, 67; tibia, 64; zygomatic width, 38; maximum length of upper cheek teeth, 16.5; of lower cheek teeth, 17.5.—Glover M. Allen, *Museum of Comparative Zoölogy, Cambridge, Massachusetts.*

A PORPOISE CHOKES ON A SHARK

On March 9, 1937, a harbor porpoise (*Phocaena phocoena*) that had been found dead the previous day on Rockaway Beach, San Mateo County, California, was brought to the Department of Mammalogy, California Academy of Sciences, by Mr. William Sommers. This animal, a young female, measuring about 40 inches in total length, was believed to have expired not more than a few minutes prior to the time that it was found. The cause of death was quite apparent. The tail of a small shark (*Mustelus californicus*) protruded about 2.5 inches from its mouth. Upon dissecting the porpoise the shark was discovered to be 22 inches long, its head being partly within the stomach of its captor. Obviously the shark had become so firmly lodged in the esophagus of the mammal that breathing was prevented. The lungs of the porpoise were filled with froth, indicating that suffocation had occurred. Apparently this young marine mammal had misjudged the size of its prey.—Robert T. Orr, *California Academy of Sciences, San Francisco, California.*

NINETEENTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

The nineteenth annual meeting of the American Society of Mammalogists was held at the United States National Museum and the United States Department of Agriculture, Washington, D. C., from May 4 to 8, 1937. There were 113 members present, representing 18 states, the District of Columbia, and two Canadian provinces.

PROGRAM

TUESDAY, MAY 4

8:00 P.M.

Meeting of the Board of Directors at the Hotel Raleigh

WEDNESDAY, MAY 5

9:30 A.M.

Registration in the Foyer, U. S. National Museum

10:00 A.M.

1. Address of Welcome. Alexander Wetmore.
2. Cross-section contours of guard hairs. Ned Dearborn.
3. Maryland muskrat marshes. Vernon Bailey.
4. The muskrat as native and alien: a chapter in the history of animal acclimatization. Tracy I. Storer.
5. New York records for the common dolphin, *Delphinus delphis*. Dayton Stoner.
6. Land improvement for the public weal: when do we inherit the earth? H. P. K. Agersborg.

2:15 P.M.

Annual Business Meeting of the Society

4:00 P.M.

7. Age estimation in deer. Tracy I. Storer.
8. Common names of mammals. Lee R. Dice.
9. Some new records and extensions of range of Canadian mammals. Rudolph M. Anderson.

THURSDAY, MAY 6

9:15 A.M.

10. What is a Nature sanctuary and what is a quasi-Nature sanctuary? H. P. K. Agersborg.
11. Report on the organization and purposes of the Committee on the Preservation of Natural conditions of the National Research Council. H. E. Anthony.
12. The winter nutritional requirements and browsing of white-tail deer in Michigan. L. A. Davenport.
13. Growth and life span in *Microtus pennsylvanicus*. Wm. J. Hamilton, Jr.
14. A study of beaver colonies in Michigan. G. W. Bradt.
15. Developments in Federal big game refuges. Stanley P. Young.
16. Studies of the cottontail rabbit in Michigan, with remarks on its present economic status. Paul Hickie.

2:15 P.M.

17. The difficulty of taking an accurate mammal census. Lee R. Dice.
18. The biology of microtine cycles and methods of making censuses. Wm. J. Hamilton, Jr.
19. Population studies with particular reference to the beavers. John Pearce.
20. Methods used in estimating deer populations. H. D. Ruhl (read by I. H. Bartlett).
21. The annual northern Yellowstone elk herd count. Victor H. Cahalane.

7:00 P.M.

The annual dinner of the Society was held in the Hotel Raleigh. After the dinner members were escorted to the auditorium of the new Interior Building where, through the courtesy of the United Artists' Corporation, they witnessed the showing of the film 'Elephant Boy,' and, through the courtesy of the Local Committee, a remarkable 'Mickey Mouse' creation.

FRIDAY, MAY 7

9:15 A.M.

22. Annual report of the American Committee for International Wild Life Protection. Harold J. Coolidge, Jr. (read by Miss Douchy).
23. An inventory of recently extinct mammals. Francis Harper.
24. Extinct musk-oxen of Indiana. M. W. Lyon, Jr.
25. The Colorado river as a barrier to mammalian distribution. E. A. Goldman.
26. The biotic provinces of Sonora, Mexico. W. H. Burt.
27. The use of nest boxes as a method of studying the nesting habits of *Peromyscus leucopus noveboracensis*. A. J. Nicholson.
28. Wolf hunting with a camera. Stanley P. Young.

2:15 P.M.

29. The Trans-Atlantic *Mus* problem. David G. Nichols.
30. The biological significance of territoriality in mammals. W. H. Burt.
31. A theory of the aquatic derivation of the moles. Berry Campbell.
32. The sequence of Pleistocene mammals in central North America. C. Bertrand Schultz.
33. Some small mammals of Mount Desert Island, Maine. M. Lelyn Branin.
34. Notes on the crab-eater and other Antarctic seals. Alton A. Lindsey.

4:15 P.M.

Final Business Meeting of the Society

8:00 P.M.

Members and guests of the Society were entertained at an informal smoker held in the mammal range of the U. S. National Museum.

SATURDAY, MAY 8

9:30 A.M.

Members and guests enjoyed a personally conducted tour through the National Zoological Park. Especially interesting was the new house for small mammals. At 1:00 P.M. the visiting members were guests of the Washington members at a luncheon in the new Pachyderm House.

At the meeting of the Directors on May 4, W. K. Gregory was re-elected as trustee for 1937–1940, and A. Brazier Howell was re-appointed as chairman of the Editorial Board.

At the annual business meeting the following officers were elected: President, Joseph Grinnell; Vice-presidents, Edward A. Preble and H. H. T. Jackson; Recording Secretary, Robert K. Enders; Corresponding Secretary, William H. Burt; Treasurer, Viola S. Schantz. Additional Directors were elected as follows: W. E. Saunders in the class of 1936–1938; Class of 1937–1939, E. Raymond Hall, William J. Hamilton, Jr., Arthur H. Howell, Remington Kellogg, Tracy I. Storer.

Dr. Leonhard Stejneger was elected unanimously to the class of Honorary Membership in token of his important contributions to the field of Mammalogy.

During the past year the Society has learned with deep regret of the deaths of the following nine members, three of whom (*) were charter members of the Society: William Frederic Badé,* Warren Francis Eaton, William T. Hornaday,* Charles E. Johnson,* Fred H. Kennard, Charles V. Noback, T. Douglas Robinson, Bryant Walker, Max Weber.

A summary of the report of the corresponding secretary follows:

New members elected at current meeting	77
New subscriptions received since last meeting	19
Total gross addition to the mailing list of the Journal	96
Resignations since last meeting	18
Deaths reported	9
Number delinquent in dues two years	41
Number delinquent in dues one year	95
Number of Honorary members	3
Number of Life members	57
Number of annual members	761
Total number of members	821
Number of subscribers	167
Total mailing list	848

Members should be pleased to learn that the Society is growing steadily in size and that its financial condition is likewise improving each year.

At the final business meeting of the Society, an invitation from the University of California, at Berkeley, to hold the 1938 annual meeting at that institution, was accepted. It was recommended, provisionally, that the 1939 and 1940 meetings be held at Baton Rouge and Toronto respectively.

Reports of the following committees were read and accepted: Editorial, Life Histories and Ecology, Marine Mammals, Conservation of Land Mammals.

The Society passed resolutions expressing its sincere appreciation to Dr. Alexander Wetmore and the staff of the U. S. National Museum, and to Dr. Ira N. Gabrielson and the staff of the U. S. Biological Survey, for facilities and courtesies extended during the meetings. Also to the Department of Agriculture and the Department of Interior for the use of rooms, to the United Artists' Corporation for the loan of the film 'Elephant Boy,' and to the Director and staff of the National Zoological Park for their kind courtesies and hospitality. To the Local Committee on Arrangements especial thanks were tendered for a well-conceived and competently carried out meeting which was pronounced a success by all who were so fortunate as to attend.

In addition the Society adopted the following resolution:

WHEREAS, there is a widespread current use of poisons by Federal, State, and private agencies in efforts to reduce the numbers of certain wild animals; and

WHEREAS, the members of the American Society of Mammalogists believe that the poisoning of mammals is considerably overdone;

Now, therefore, be it Resolved by the American Society of Mammalogists that this Society asks that poisoning be discontinued except in cases where investigation has shown that such action is necessary for human welfare and protection of health.

REVIEWS

Chapman, Wendell and Lucy. WILDERNESS WANDERERS. Charles Scribners Sons, New York and London, 1937.

To those who have read "The Little Wolf" and "Beaver Pioneers," the Chapmans will need no introduction, but in "Wilderness Wanderers" they have set a new level, so far as I can judge never before attained, of thrilling interest in the intimate facts of the habits and home life of our native animals. Instead of carrying guns and traps and shooting or collecting the animals on sight, they have carried cameras and taken all the time necessary to live with the animals, make friends of them, understand their wordless language, and bring back to us not only the best moving and still pictures ever taken in this country but perfect word pictures of how unfrightened animals behave, work, play, love and fight. There is no romancing in the book and the facts are carefully and accurately given with the simple charm of understanding and appreciation of all out-of-doors. A strong plea for practical conservation runs through it, but conservation based on a fuller and better knowledge than we have ever before had. It would be hard to find more first-hand, unrecorded information in any book on mammals that comes to my mind; on the beavers, bighorns, elk, buffalo, bears, mountain goats, antelope, otters, marten, weasels and many of the small forms of animal life of the northern Rocky Mountains.

The book is expensive ($3.75), but could not be otherwise with large print, good paper and a wealth of illustrations unequalled in any recent publication on our native mammals.—VERNON BAILEY.

Reck, H. (Editor). WISSENSCHAFTLICHE ERGEBNISSE DER OLDOWAY-EXPEDITION 1913, NEUE FOLGE, HEFT 4. Verlag von Dietrich Reimer (Andrews and Steiner), Berlin, 1937, Pp. 1–142, plates I–VIII.

After a delay of 9 years, the publication of the scientific results of Dr. Reck's East African work is now continued in this important volume. Each Heft now appears as an independent large quarto publication, the present one being devoted entirely to Pleistocene mammals from Oldoway. Ernst Schwarz treats the fossil antelopes, W. O. Dietrich the suids, giraffids, and bovines, A. Tindell Hopwood the horses, and Hans Reck a single new bovid, *Thaleroceros*. Of these the longest section is that on the antelopes, which constitute the greater part of the Pleistocene as of the Recent fauna. This is accompanied by a brief review of the Bovidae in general in which Schwarz proposes the following arrangement:

Section I: Subfamily Cephalophinae.

Section II: Subfamilies; Tragelaphinae, Boselaphinae, Bovinae.

Section III: Subfamilies; Reduncinae, Neotraginae, Antilopinae, Hippotraginae, Caprinae.

Section IV: Subfamily Antilocaprinae.

There is given a complete list of genera referred to each subfamily. The Oldoway antelopes themselves are mostly referable to *Gorgon*, *Alcelaphus*, and *Damaliscus*, but more fragmentary and rare remains bring the whole list of bovids to 16 genera with 20 species, of which 11 genera and 14 species are antelopes discussed in this paper. Unfor-

tunately, in dealing with the teeth, Dr. Schwarz uses a modified cusp nomenclature less generally applicable than that of Osborn, apparently no more accurate topographically, and unnecessarily confusing to anyone accustomed to the usual system. The materials are fragmentary for the most part, but have been identified with great labor and skill.

The suid remains are also scanty. There are two fair skulls but no specific identifications are made. The genera are *Koiropotamus* (*Potamochoerus* of authors), *Phacochoerus* and *Notochoerus* or *Metridiochoerus*. A sivathere, giraffe (*sensu stricto*), and buffalo (*Bubalus*) are present, but the remains are too imperfect to show much more than the bare fact of occurrence.

The equids include a hipparion, referred to *Stylohipparion* van Hoepen, and an extinct zebra. Without discussing the question in detail, Dr. Hopwood throws additional doubt on van Hoepen's derivation of modern horses and zebras from *Hipparion*, and he also independently and tentatively suggests a derivation of *Equus grevyi* from the species usually called *Equus stenonis*. Despite pronounced differences elsewhere, some isolated limb bones of *Hipparion* and *Equus* are found to be indistinguishable.

Thaleroceros, described in the last brief section of this volume, is a strange bovid, possibly related to *Cervicapra*, with peculiarly erect, approximated, and recurved horns.

General conclusions on the fauna and stratigraphy are not included in this series of papers, but the special interest of the Oldoway fauna is to some extent suggested by Dr. Hopwood, who points out that the peculiarity of the fauna is its mingling of archaic forms (Pliocene in aspect but here apparently in the Middle Pleistocene) with what is essentially the modern fauna of the same region. This work is a necessity for anyone interested in the origin of the African fauna or in the Pleistocene sequence of that continent. It is ably done throughout and handsomely published. The only element of disappointment is in the fact that despite its impressive format this publication may not be definitive, since many of these species are represented by better material in other collections.

The new names proposed are: *Taurotragus oryx pachyceros* Schwarz, *Gazella gazella praecursor* Schwarz, *Phenacotragus* Schwarz, *P. recki* Schwarz, *Damaliscus angusticornis* Schwarz, *Equus oldowayensis* Hopwood, *Thaleroceros* Reck, and *T. radiciformis* Reck.—G. G. Simpson.

LIST OF RECENT LITERATURE

[Conducted by Arthur H. Howell, Remington Kellogg, and Gerrit S. Miller, Jr.]

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OBITUARY NOTICE

MAX WEBER

Max Weber, honorary member of the American Society of Mammalogists, died at his country house in Eerbeek, Holland, on February 7, 1937. He was born December 5, 1852, at Bonn, and studied biology and medicine at the University of Bonn and at Berlin. In 1877 he took his doctor's degree at Bonn. In 1879 he went to Holland, first as prosector of anatomy at the University of Amsterdam, then as lecturer in anatomy at the University of Utrecht (1880), and finally as professor of zoology again at the University of Amsterdam, which post he held until 1922, when he became professor emeritus. The remainder of his life was spent at Eerbeek, working in his private laboratory.

Max Weber is well known as the leader of the Netherlands Deep Sea Expedition of the "Siboga," to the seas of the eastern part of the Netherlands East Indies. He also acquired great fame as an ichthyologist, and through his other zoogeographical work, but what interests us here especially is his work as a mammalogist.

His first important contributions to the knowledge of this class date from 1885. He was then interested in the Cetacea, an order that was of concern to him throughout his whole life. Accompanied by his wife, Anna van Hosse, a well known botanist and specialist of algae, who survives him, he made several trips to the whaling station at Tromsö, where he had an opportunity to study the anatomy of these huge mammals. He further utilized every whale stranded on the Netherlands coast to increase his knowledge, and in the course of time he wrote 10 papers on whales.

The zoological laboratory of the University of Amsterdam is situated in the zoological gardens. This has the great advantage that many rare animals can be studied and dissected after death In this way Weber collected voluminous data on mammals.

It must have been about this time that the well known French zoologist Blanchard asked and obtained Weber's collaboration for a great zoological work, in which Weber would report on the Mammalia. Henceforth Weber concentrated still more on this class. In 1888, again accompanied by his wife, he made a private expedition to the Netherlands East Indies, and the results were embodied in a work that he published at his own expense. Weber now became interested in the hairs of mammals, and specially in their grouping during growth. He studied the correlation between these groups and the squamation, as in *Manis*, and on the tail of rats and mice. At the suggestion of Weber, one of his pupils (now professor emeritus), Dr. J. C. H. de Meyere, continued these studies.

Investigations on the correlation between the weight of the brain and the body-weight in mammals had already been started in 1888, and they were continued from time to time during subsequent years, resulting in two papers.

Meanwhile, in 1894, Weber and his wife had made a trip to South Africa, where mammals were collected for systematic and anatomical studies. No special paper on mammals written by Weber resulted from this expedition, but he used the results of his investigations when writing his paper on the descensus testiculorum. The projects of Blanchard mentioned above came to nothing, and Weber decided therefore to publish a volume on mammals, on which he had been working for so many years. In fact, all his former studies on mammals were planned with this work in view. In 1904 his "Säugetiere" was issued. In a masterly way Weber treated in this volume the mammals from an anatomical, systematic, and palaeontological standpoint. It has been invaluable to all later students of mammalogy. Soon it was out of print and a second edition was issued in 1927. In the meantime our knowledge of this class had increased to such an extent that it was necessary to divide the work into two volumes. The first, issued in 1927, contains the anatomy. Dr. H. M. de Burlet coöperated in this part. The second

volume contains the systematic and palaeontological parts, and a chapter on zoogeography. Professor Abel collaborated in some of the palaeontological chapters. Weber dedicated this volume to professors H. F. Osborn, W. D. Matthew, and W. K. Gregory, "the promoters of mammalogy." At that time Weber was 76 years old, and although he remained at work until 1936, this marked the close of his mammalogical studies, which he had followed for more than 40 years. The value of his work to mammalogy can hardly be exaggerated.—L. F. DE BEAUFORT.

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(Corrected to June 1, 1937)

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Bailey, Vernon, 1834 Kalorama Road, Washington, D. C. ..... Charter
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Frick, Childs, Roslyn, Long Island, N. Y. ..... Charter
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Pope, Gustavus D., 1020 Ford Bldg., Detroit, Mich. 1924
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Rothschild, Lionel Walter Lord, Zoological Mus., Tring, Herts, England ..... Charter
Scalon, W. W., Pesterevskaja 16 Irkoutsk, Siberia, Vostsibponchnina, U.S.S.R. 1927
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Abbott, Clinton G., Natural History Mus., San Diego, Calif. 1922
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Adams, Harry, U. S. Forest Service, Milwaukee, Wis. 1937
Adams, William C., State Conservation Dept., State Office Bldg., Albany, N. Y. 1926
Adams, Dr. Zabdiel Boylston, 43 Cottage Farm Road, Brookline, Mass. 1936
Agacino, E. Morales, Museo Nacional de Cienecias Naturales, Hippodromo, Madrid (6), Spain 1933
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Beaux, Prof. Dr. Oscar de, Via Brigata Liguria 9, Genoa, Italy 1930
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Bluntschli, Prof. Dr. Hans, Anatom. Inst., Aebistrasse 9, Bern, Switzerland 1930
Bode, Dr. Francis D., California Inst. of Technology, Pasadena, Calif. 1931
Bode, I. T., U. S. Biological Survey, Washington, D. C. 1936
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Bown, Miss Olive Lynda, 6210 Wellesley Ave., Pittsburgh, Pa. 1935
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Braestrup, Dr. Frits Wimpffen, St. Kannikestraede, 9, Copenhagen K., Denmark .. 1934
Brand, Albert R., 9 E. Ave., Ithaca, N. Y. 1933
Brassard, Dr. A., Director, Quebec Zoological Garden, Charlesbourg, Quebec, Canada 1934
Breck, Mrs. Edward, 1343 19th St., Washington, D. C. 1930
Breckenridge, W. J., Mus. of Natural History, Univ. of Minn., Minneapolis, Minn. .. 1932
Brewer, Dr. George E., 151 East 79th St., New York City 1934
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Burke, J. J., Carnegie Mus., Pittsburgh, Pa. 1935
Burnham, John B., Essex, N. Y. 1923
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Burt, Dr. Chas. E., Southwestern College, Winfield, Kans. 1931
Burt, Dr. Wm. H., Mus. of Zoology, Univ. of Michigan, Ann Arbor, Mich. 1926
Butler, Dr. Amos W., 52 Downey Ave., Irvington, Indianapolis, Ind. ..... Charter
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Caldwell, Dr. George Thornhill, Box 4051, University Station, Tucson, Ariz. 1922
Campbell, Dr. Berry, Laboratory of Anatomy, Western Reserve Univ., Cleveland, Ohio 1934
Campbell, Dr. J. A., 13 Elm St., Toronto, Ontario, Canada 1920
Canter, Dr. Nathan, 648 Washington Blvd., Baltimore, Md. 1936
Cantwell, Geo. G., Los Angeles Mus., Los Angeles, Calif. ..... Charter
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Carroll, Dr. Mitchel, Franklin & Marshall College, Lancaster, Pa. 1922
Carter, T. Donald, Amer. Mus. Nat. Hist., New York City 1922
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Chaffee, Robert G., 162 South Main St., Rutland, Vt. 1936
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Chapman, F. B., Ohio Wildlife Res. Station, Ohio State Univ., Columbus, Ohio 1937
Chapman, Dr. Wendell S., 2934 Magnolia, Berkeley, Calif. 1934
Charters, Emma M., U. S. Biological Survey, Washington, D. C. 1921
Chase, Henry B., Jr., 517 Decatur St., New Orleans, La. 1924
Chaworth-Musters, James Lawrence, British Mus. (Natural History), London, S. W. 7, England 1933
Cheesman, William H., U. S. Biological Survey, Washington, D. C. ..... Charter
Church, Morton L., 1626 Queens Road West, Charlotte, N. C. ..... Charter
Clark, Elton, Pomfret, Vt. ..... Charter
Clark, Dr. James L., Amer. Mus. Nat. Hist., New York City 1926
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Coe, Ernest F., Everglades National Park Assoc., County Court House, Miami, Fla. .. 1936
Colbert, Dr. Edwin H., Amer. Mus. Nat. Hist., New York City 1930
Cole, Dr. Leon J., College of Agriculture, Univ. of Wisconsin, Madison, Wis. 1922
Coleman, Robert H., College of Charleston, Charleston, S. C. 1928
Collins, Henry H., Jr., South Bldg., Dept. Agriculture, Washington, D. C. 1932
Collins, Dr. Homer H., Dept. of Biology, Univ. of Pittsburgh, Pittsburgh, Pa. 1921
Compton, Lawrence V., Box 1314, Soil Conservation Service, Albuquerque, N. Mex. . 1929
Conisbee, L. R., Esq., 34 Downs Road, Hastings, Sussex, England 1936
Conway, Ralph C., 1032 W. Dayton St., Madison, Wis. 1937
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Dale, Fred H., Box 422, Belton, Mont. 1935
Dalke, Dr. Paul D., 116 Benton St., Manchester, Conn. 1928
Dalquest, Walter, 6521 17th St., N. E., Seattle, Wash. 1937
Dammerman, Karl Willem, Zool. Mus. & Lab., Buitenzorg, Java ..... Charter
Damon, David, 4519 N. 16th St., Omaha, Nebr. 1935
Danforth, Stuart T., Box 541, Mayaguez, Puerto Rico 1925
Darling, Prof. C. A., Dept. of Biology, Allegheny College, Meadville, Pa. 1935
Darling, Dr. Jay N., Des Moines, Iowa 1934
Darrow, Robert W., Elizabethtown, Essex County, N. Y. 1932
Davis, David E., 721 Elmwood Ave., Wilmette, Ill. 1936
Davis, Eli., R. R. No. 7, London, Ontario, Canada 1930
Davis, George W., 377 Orange Street, Albany, N. Y. 1935

Davis, William B., Mus. of Vertebrate Zoology, Berkeley, Calif.....1934
Day, Albert M., U. S. Biological Survey, Washington, D. C.....1924
Dearborn, Dr. Ned, Hilton Village, Va.....Charter
Deichmann, Elizabeth, Mus. of Comparative Zoology, Cambridge, Mass.....1925
De Lury, Ralph E., Dominion Observatory, Ottawa, Canada.....1925
Demeritt, Prof. D. B., Dept. of Forestry, Univ. of Maine, Orono, Maine.....1936
Denison, Robert H., 42 Fletcher St., Winchester, Mass.....1934
Dice, Dr. Lee R., Mus. of Zoology, Univ. of Michigan, Ann Arbor, Mich.....Charter
Dickinson, Francis R., 1518 Astor St., Chicago, Ill.....1930
Dille, Frederick M., Box 428, Rapid City, S. Dak.....Charter
Dillehunt, Harry B., Jr., 214 W. Read St., Baltimore, Md.....1926
Ditmars, Dr. Raymond L., New York Zool. Park, New York City.....1921
Dixon, Joseph Scattergood, 1735 Allston Way, Berkeley, Calif.....Charter
Donahue, Mrs. R. W., Peabody Mus. Library, Yale University, New Haven, Conn..1930
Donaldson, Dr. Henry H., The Wistar Institute, Philadelphia, Pa.....Charter
Dorsh, John B., College, Alaska.....1934
Doutt, J. Kenneth, Carnegie Mus., Pittsburgh, Pa.....1927
Duff, John R., Public Works Dept., Christchurch, New Zealand.....1925
Dunk, F. A., Prov. Mus., Normal School, Regina, Saskatchewan, Canada.....1929
Dunn, Prof. E. R., Haverford College, Haverford, Pa.....1927
Durrant, Stephen D., Dept. of Zoology, Univ. of Utah, Salt Lake City, Utah.....1933
Dwinelle, J. K., 1220 Vine St., Missoula, Mont.....1936
Eadie, W. Robert, Dept. of Zoology, Univ. of New Hampshire, Durham, N. H.....1936
Eastwood, Sidney K., 301 S. Winebiddle Ave., Pittsburgh, Pa.....1930
Edge, Mrs. Charles N., 136 E. 67th St., New York City.....1930
Edge, Dr. Elton R., San Bernardino Valley Union Jr. College, San Bernardino, Calif.....1931
Edinger, Dr. Tilly, Leerbachstrasse 27, Frankfurt a. M., Germany.....1933
Edson, John M., 90 Marine Drive, Bellingham, Wash.....Charter
Edwards, Glen, Box 672, College Station, Pullman, Wash.....1936
Êhik, Dr. Julius, Hungarian National Mus., Budapest, 80, Hungary.....1923
Eifrig, Prof. C. W. G., 1029 Monroe Ave., River Forest, Ill.....Charter
Ekblaw, Prof. W. Elmer, Clark Univ., Worcester, Mass.....1921
Elftman, Dr. Herbert, Scheimerhorn Hall, Columbia Univ., New York City.....1926
Elliott, Mrs. Jane S., Biological Survey, Washington, D. C.....Charter
Elson, Paul F., Dept. of Biology, Univ. of Toronto, Toronto, Canada.....1936
Elton, Charles, University Mus., Oxford, England.....1931
Emilio, S. Gilbert, 7 Winter St., Salem, Mass.....1937
Emlen, John T., Jr., College of Agriculture, Davis, Calif.....1934
Enders, Dr. Robt. K., Swarthmore College, Swarthmore, Pa.....1924
Engels, William L., Mus. of Vertebrate Zoology, Berkeley, California.....1930
English, Dr. P. F., Dept. of Forestry, Conn. State College, Storrs, Conn.....1922
Errington, Dr. Paul L., Insectary, Iowa State College, Ames, Iowa.....1933
Evans, Dr. Thomas Horace, 350 S. Main St., Freeport, N. Y.....1935
Evans, T. R., 312 Penn St., Huntingdon, Pa.....1936
Ewing, Dr. H. E., U. S. National Mus., Washington, D. C.....1923
Eyerdam, Walter J., 7531 19th St., N. E., Seattle, Wash.....1931
Fargo, William G., 506 Union St., Jackson, Mich.....1928
Ferdinand, Wilhelm H., Firm of Carl Hagenbeck, Stellingen, Germany.....1931
Festa, Dr. Enrico, Regio Museo Zoologico, Via Accademia Albertina, 17, Torino, Italy.....1925
Figgins, J. D., The Britling, 343 S. Main, Lexington, Ky.....Charter

Filley, Oliver D., Bernardsville, N. J. 1930
Finley, William L., Box 426 A, Route 10, Portland, Oreg. ..... Charter
Fisher, Miss Edna M., 2410 Fulton St., Berkeley, Calif. 1928
Fitch, Dr. C. P., University Farm, St. Paul, Minn. 1937
Fitzgerald, Alice, 3422 81st St., Jackson Heights, Long Island, N. Y. 1936
Fleming, J. H., 267 Rusholme Road, Toronto, Canada ..... Charter
Follett, Richard E., Detroit Club, Detroit, Mich. 1926
Fortuyn, Dr. A. B. Droogleever, Peiping Union Medical College, Peiping, China 1931
Foster, Frank B., Montcalm Farms, Phoenixville, Pa. 1926
Foster, Mark A., Wis. Gen. Hospital, Madison, Wis. 1935
Fox, Adrian Casper, U. S. Soil Conservation Service, Park River, N. Dak. 1935
Fox, Herbert, Zool. Soc. of Philadelphia, Philadelphia, Pa. 1927
Fraser, Dr. Charles M., Univ. of British Columbia, Vancouver, B. C., Canada 1921
Frechkop, M. Serge, Musee royal d'Histoire nat. de Belgique, 31 rue Vautier, Bruxelles, Belgium 1933
Fredine, C. Gordan, 50 S. Cretin Ave., St. Paul, Minn. 1937
Fricke, Reinhold L., Carnegie Mus., Pittsburgh, Pa. 1932
Frost, Wilfrid T., Wildlife Ranger of Crater Lake National Park, Fort Klamath, Oreg. 1937
Fry, William W., 6420 Cecil Ave., St. Louis, Mo. 1933
Fuller, Arthur B., Broadmoor Road, Midland Moor, Mentor, Ohio ..... Charter
Fuller, Henry C., 3704 Huntington St., Washington, D. C. 1926
Furlong, E. L., California Inst. Technology, Pasadena, Calif. 1925
Gabrielson, Dr. Ira N., U. S. Biological Survey, Washington, D. C. ..... Charter
Gaige, Prof. Frederick M., Mus. of Zoology, Ann Arbor, Mich. 1929
Gates, Dr. Wm. H., Univ. Station, Baton Rouge, La. 1930
Gault, Benj. T., 563 N. Main St., Glenellyn, Ill. ..... Charter
Gazin, Dr. Charles Lewis, U. S. National Mus., Washington, D. C. 1931
Geist, Otto W., Mus. Dept., Univ. of Alaska, College, Alaska 1931
Ghigi, Prof. Alessandro, Dept. of Zoology, Univ. of Bologna, Bologna, Italy 1926
Gilmore, Raymond M., International Health Division, Rockefeller Foundation, 49 W. 49th St., New York City 1926
Gloyd, Dr. Howard Kay, Chicago Acad. Sci., 2001 N. Clark St., Chicago, Ill. 1922
Goff, Carlos C., Watermelon & Ornamental Field Laboratory, Leesburg, Fla. 1934
Goldman, Maj. E. A., U. S. Biological Survey, Washington, D. C. ..... Charter
Goldman, Luther C., 2702 17th St., Washington, D. C. 1937
Goldman, Luther J., 1092 Keith Ave., Berkeley, Calif. 1922
Goldsmith, Dr. G. W., Box 1611, Univ. Station, Austin, Tex. 1922
Goldsmith, Dr. Wm. M., Univ. of Wichita, Wichita, Kans. 1924
Good, E. E., Soil Conservation Service, Hamilton, Ohio 1937
Goodwin, George G., Amer. Mus. Nat. Hist., New York City 1921
Gordon, Kenneth, Oregon State College, Corvallis, Oreg. 1936
Gorham, Frank W., 732 W. Central Ave., Highland Park, Ill. 1936
Goslin, Robert, 312 Wilson Ave., Columbus, Ohio 1931
Granger, Dr. Walter, Amer. Mus. Nat. Hist., New York City ..... Charter
Grant, Cleveland, 620 Greenup St., Covington, Ky. 1926
Gray, A. E., 1016½ N. W. 20th St., Oklahoma City, Okla. 1924
Green, Hubert U., Mistamick Lodge, Daupin, Manitoba, Canada 1931
Green, Marcus H., Albright College, Reading, Pa. 1935
Green, Dr. Robert G., 223 Millard Hall, Univ. of Minnesota, Minneapolis, Minn. 1933
Greenfield, Ray H., 124 Maple Ave., Takoma Park, Md. 1928
Greffinius, R. J. E., U. S. Forest Service, Hayden, Colo. 1937

Gregg, H. R., National Park Service, Hot Springs National Park, Ark.....1935
Gregory, S. S., Jr., Box N. Winnetka, Ill.....1927
Gregory, Dr. Wm. K., Amer. Mus. Nat. Hist., New York City.....Charter
Griffin, Donald, Barnstable, Mass.....1929
Grinnell, Dr. Joseph, Mus. of Vertebrate Zoology, Berkeley, Calif.....Charter
Grinnell, Mrs. Joseph, 2737 Forest Ave., Berkeley, Calif.....1923
Grosvenor, Gilbert, Hubbard Memorial Hall, Washington, D. C.....1921
Guthrie, Mary J., Lefever Hall, Univ. of Missouri, Columbia, Mo.....1930
Gyger, Dr. May Katharine, Perris, Calif.....1934
Gyldenstolpe, Nils (Count), Naturh. Riksm., Stockholm 50, Sweden.....Charter
Haag, William G., Box 307, Wilson Dam, Ala.....1936
Hadsall, Dr. Leo F., Fresno State College, Fresno, Calif.....1936
Haecker, Harold H., 421 Federal Bldg., Lincoln, Nebr.....1936
Hagner, Dr. Francis R., 1824 19th St., N. W., Washington, D. C.....1925
Hall, Dr. E. Raymond, Mus. of Vertebrate Zoology, Berkeley, Calif.....1923
Hall, Dr. F. Gregory, Duke Univ., Durham, N. C.....Charter
Halloran, Arthur Franklin, Pitkin, Colo.....1934
Hamerstrom, Dr. Frederick N., Jr., Resettlement Administration, Necedah, Wis...1936
Hamilton, Dr. Wm. J., Jr., Dept. of Zoology, Cornell Univ., Ithaca, N. Y.....1924
Hamlett, Dr. G. W. D., Carnegie Lab. of Embryology, Wolfe & Madison Sts., Baltimore, Md.....1936
Hampe, Dr. Irving Edward, 2527 W. North Ave., Baltimore, Md.....1936
Hanington, Chas. H., Colorado Mus. Nat. Hist., Denver, Colo.....1936
Harkin, J. B., Commissioner of Dominion Parks, Dept. of the Interior, Ottawa, Canada.....Charter
Harkins, Daniel J., Franklin Park Zoo, Grove Hall P. O., Boston, Mass.....1929
Harper, Dr. Francis, 224 S. Chester Road, Swarthmore, Pa.....Charter
Harris, Harry, 5234 Hermosa Ave., Eagle Rock, Calif.....Charter
Harrison, F. A., Dept. of Lands & Forests, Halifax, Nova Scotia, Canada.....1934
Harrison, George L., 1520 Locust St., Philadelphia, Pa.....Charter
Harrower, Dr. David E., 1032 W. Broadway, Woodmere, Long Island, N. Y.....1932
Hartman, Prof. Carl G. Carnegie Laboratory of Embryology, Wolfe & Madison Sts., Baltimore, Md.....1921
Harwell, C. A., Yosemite Museum, Yosemite National Park, Calif.....1927
Harwood, P. LeRoy, The Mariners Savings Bank, New London, Conn.....1932
Haskin, Nagel, 6712 Wis. Ave., Chevy Chase, Md.....1926
Hatfield, Donald M., Div. of Economic Zoology, Univ. of Minnesota, St. Paul, Minn.....1933
Hatt, Dr. Robert T., Cranbrook Institute of Science, Bloomfield Hills, Mich.....1921
Haven, Herbert M. W., 500 Forest Avenue, Portland, Maine.....Charter
Hawbecker, A. C.. 34 A Jefferson St., Watsonville, Calif.....1937
Hawkins, Arthur S., New Soils Bldg., Madison, Wis.....1935
Hayne, Don, Mus. of Zoology, Univ. of Michigan, Ann Arbor, Mich.....1933
Heck, Prof. Dr. Ludwig, Budapester-Strasse 9, Berlin W 62, Germany.....1928
Heilner, Van Campen, Spring Lake Beach, N. J.....1928
Heller, Edmund, Park Lodge, Golden Gate Park, San Francisco, Calif.....Charter
Hellman, Dr. Milo, 57 W. 57th St., New York City.....1921
Helme, Arthur H., 223 Bayview Terrace, Port Jefferson, N. Y.....Charter
Helmuth, Dr. William Tod, 3d, 667 Madison Ave., New York City.....1932
Henderson, Walter C., 8 Magnolia Parkway, Chevy Chase, Md.....Charter
Hendrickson, George O., Dept. of Zoology, Iowa State College, Ames, Iowa.....1937
Henn, Dr. Arthur W., Carnegie Mus., Pittsburgh, Pa.....1930

Heptner, Dr. Vladimir G., Ul. Gerzena, 6, Zool. Museum Univ. Moscou 9, U.S.S.R..1932
Hering, Paul E., Oglethorpe Univ., Oglethorpe, Ga.....1930
Herpich, Fred C., Peabody Mus., Yale Univ., New Haven, Conn.....1930
Hershkovitz, Philip, 3153 Breckenridge, Schenley Heights, Pittsburgh, Pa.....1932
Herzog, Dr. Dietrich, Marstallstrasse 4/1, Munchen 2 No., Germany.....1931
Hibbard, Claude W., Mus. of Paleontology, Univ. of Kansas, Lawrence, Kans.....1932
Hickie, Paul F., 622 Leslie St., Lansing, Mich.....1931
Hicks, Dr. Lawrence E., Coöperative Wildlife Res. Station, Ohio State Univ., Columbus, Ohio 1936
Hill, Dr. John E., Amer. Mus. Nat. Hist., New York City.....1930
Hilzheimer, Dr. Max., Wallstrasse 52/54, Markisches Museum, Berlin, S-14, Germany.....1925
Hindman, William M., DeKalb, Missouri.....1936
Hiner, Lawrence E., 4230 Blaisdell, South, Minneapolis, Minn.....1936
Hinshaw, Thos. D., 1908 Scottwood Ave., Ann Arbor, Mich.....1936
Hinton, M. A. C., British Mus. (Natural History), London, S. W. 7, England.....1930
Hisaw, Prof. Frederick L., Biological Laboratory, Harvard Univ., Cambridge, Mass.....Charter
Hochbaum, Hans Albert, Mariemont Inn, Cincinnati, Ohio.....1935
Hodges, Charles H., Jr., 59 Kenwood Road, Grosse Pointe Farms, Mich.....1927
Holden, Guerdon S., 8907 Lake Shore Blvd., Cleveland, Ohio.....1937
Hollister, Mrs. Mabel P., 1819 Ontario Place, N. W., Washington, D. C.....1925
Holman, John P., Fairfield, Conn.....1921
Holt, Ernest G., 2121 New York Ave., N. W., Washington, D. C.....Charter
Hone, Elizabeth B., Lyons Falls, Lewis County, N. Y.....1933
Hooper, Emmet T., Mus. of Vertebrate Zoology, Berkeley, Calif.....1934
Hoover, Earl E., 32 S. Main St., Concord, N. H.....1936
Hopwood, Dr. A. T., Dept. Geol., British Mus. (Nat. Hist.), London, S. W. 7, England.....1930
Horring, H., Zoologisk Museum, Copenhagen, Denmark.....1924
Horsfall, R. Bruce, 3835 S. St., N. W., Washington, D. C.....Charter
Hoslett, Sherman Anderson, Luther College, Decorah, Iowa.....1932
Hosley, Neil W., Harvard Forest, Petersham, Mass.....1933
House, E. J., 57 Fidelity Bldg., Pittsburgh, Pa.....1926
Howard, Dr. Edgar B., Bryn Mawr, Pa.....1936
Howard, John K., 55 Congress St., Boston, Mass.....1928
Howard, Wm. J., National Park Service, 801 Grace Securities Bldg., Richmond, Va..1935
Howell, Arthur H., 2919 S. Dakota Ave., N. E., Washington, D. C.....Charter
Hoy, Dr. Wm. E., Jr., Dept. of Biology, Univ. of S. C., Columbia, S. C.....1922
Hubback, Theodore R., Sunlaws, Bukit Betong, Kuala Lipis, Pahang, Fed. Malay States.....1922
Huber, Wharton, Academy of Natural Sciences, Philadelphia, Pa.....1922
Huestis, Prof. R. R., Dept. of Zoology, Univ. of Oregon, Eugene, Oreg.....1927
Huey, Laurence M., Mus. of Natural History, Balboa Park, San Diego, Calif...Charter
Hughes, Gwladys F., 4108 Springdale Ave., Baltimore, Md.....1937
Hungate, Prof. J. W., State Normal School, Cheney, Wash.....1925
Inkley, Scott R., 5124 Spencer Road, Lyndhurst, Ohio.....1936
Jackson, Prof. C. F., Dept. of Zoology, Univ. of N. H., Durham, N. H.....1921
Jackson, Mrs. Hartley H. T., 6313 Ridgewood Ave., Chevy Chase, Md.....Charter
Jackson, Herbert W., Zool. Lab., McGraw Hall, Cornell Univ., Ithaca, N. Y.....1936
Jackson, Ralph W., Route No. 1, Cambridge, Md.....1921
Jacobson, Karl A., Division of Wildlife Res., Univ. of Maine, Orono, Maine.....1937

Jacot, E. C., Box 462, Prescott, Ariz.....1921
James, Norman, The James Lumber Co., P. O. Box D2, Baltimore, Md.....Charter
Jeffers, Edmund E., Dept. of Zoology, Univ. of Ind., Bloomington, Ind.....1937
Jeffers, Dr. Katharine R., Lefevre Hall, Columbia, Mo.....1936
Jellison, Wm. L., Hamilton, Mont.....1931
Jenkins, Hubert Oliver, 2116 3d Ave., Sacramento, Calif.....1936
Jenks, Randolph, Rancho Esperero, Univ. Station, Tucson, Ariz.....1932
Jepsen, Glenn L., Dept. of Geology, Princeton Univ., Princeton, N. J.....1930
Jewett, Stanley G., 1404 Bidwell St., S. E., Portland, Oreg.....Charter
Johnson, Dr. Arthur M., Dept. of Biology, Univ. of Calif., Los Angeles, Calif.....1923
Johnson, David H., Mus. of Vertebrate Zoology, Berkeley, Calif.....1933
Johnson, Frank W., Apartado 172, C/o Lago Petroleum Corporation, Maracaibo, Venezuela, S. A.....1932
Johnson, Julius M., 293 S. Pleasant Ave., Ridgewood, N. J.....1924
Johnson, Maynard S., 39 Summer St., Saugus, Mass.....1923
Johnson, Murray L., C/o Theta Kappa Psi, Marguam Hill, Portland, Oreg.....1936
Johnson, Dr. Paul B., 3208 17th St., N. W., Washington, D. C.....1924
Jones, Gordon W., Elwood, Wilderness, Va.....1934
Jones, Walter H., 227 Haverford Ave., Swarthmore, Pa.....1937
Jones, S. Paul, 509 West Ave. N., Waukesha, Wis.....1929
Kalmbach, E. R., C/o U. S. Biological Survey, 526 Custom House, Denver, Colo.....1925
Kalter, Louis B., 535 Belmont Park, N., Dayton, Ohio.....1935
Kashkarov, Dr. Daniel, Dept. of Ecology and Biology, Univ. of Leningrad, Leningrad, U.S.S.R.....1930
Katz, J. S., Ohio Wildlife Res. Sta., Ohio State Univ., Columbus, Ohio.....1937
Kay, J. LeRoy, Carnegie Mus., Pittsburgh, Pa.....1935
Keays, J. E., 328 George St., London, Ontario, Canada.....1924
Keeble, Lilian, 422 E. 58th St., New York City.....1935
Kelker, George H., R. D. 3, Garrettsville, Ohio.....1932
Keller, Leslie Floyd, Zion National Park, Utah.....1935
Kellogg, John P., 231 South La Salle St., Chicago, Ill.....1934
Kellogg, Dr. Remington, U. S. National Mus., Washington, D. C.....Charter
Kendeigh, Dr. S. Charles, 204 Exp. Zool. Lab., Champaign, Ill.....1937
Kidder, Nathaniel T., Milton, Mass.....1921
King, Dr. Helen D., Wistar Inst. of Anatomy, Philadelphia, Pa.....1930
Kirkwood, Frank C., Phoenix, Baltimore County, Md.....Charter
Knappen, Miss Phoebe, U. S. Biological Survey, Washington, D. C.....1928
Knecht, Karl Kae, Mesker Zoo., 31 Adams Ave., Evansville, Ind.....1936
Kobes, Karl, Division of Economic Zoology, Univ. of Minn., St. Paul, Minn.....1937
Komarek, E. V., Sherwood Plantation, Thomasville, Ga.....1928
Komarek, Roy V., 2001 N. Clark St., Chicago Academy of Sci., Chicago, Ill.....1935
Krauss, N. H., 2557 Parker Place, Honolulu, Hawaii.....1929
Krefting, Laurita W., Grand Marais, Minn.....1937
Kuhn, Uhl R., 1350 14th St., Douglas, Ariz.....1935
Kummerlowe, Dr., Museum für Tierkunde, Dresden 1, Germany.....1930
Kunkel, Kenneth M., Conservation Dept., State House, Indianapolis, Ind.....1933
Kuroda, Dr. Nagamichi, Fukuyoshi Cho, Akasaka, Tokyo, Japan.....Charter
La Due, Harry J., St. Peter, Minn.....1927
Lagler, Karl F., University Mus., Ann Arbor, Mich.....1936
Landberg, R. L., Colorado Mus. of Natural History, Denver, Colo.....1927
Landwer, M. Frederic, Biology Dept., Texas Tech., Lubbock, Tex.....1933
Lane, Prof. H. H., Dept. Zoology, Univ. of Kansas, Lawrence, Kans .....Charter

Langstroth, James H., Silver City, N. Mex. 1926
Langworthy, Dr. O. R., Johns Hopkins Hospital, Baltimore, Md. 1928
Lauckhart, Burton, 4750 Thackery Place, Seattle, Wash. 1936
Lawrence, Barbara, Mus. of Comparative Zoology, Cambridge, Mass. 1933
Leavenworth, Mrs. Ellis W., 320 E. 72d St., New York City 1935
Lee, Robt. E., U. S. Soil Conservation Service, Greenfield, Iowa 1937
Leeds, Arthur N., 1025 Westview St., Mt. Airy, Pa. 1931
Leister, C. W., N. Y. Zoological Park, New York City ..... Charter
Leopold, Dr. Aldo, Old Economic Entomology Bldg., Univ. of Wisc., Madison, Wis. ..... Charter
Leraas, Dr. Harold J., Pacific Lutheran College, Parkland, Wash. 1932
Lewis, John B., P. O. Box 86, Amelia, Va. 1926
Lewis, Dr. Nolan D. C., 722 W. 168th St., New York City 1927
Licking, Clyde, P. O. Box 149, Omaha, Nebr. 1931
Lincoln, Alexander, Jr., 59 Codman Road, Brookline, Mass. 1935
Lindsey, Alton A., 209 Church St., Mount Pleasant, Pa. 1937
Link, Miss Ethel Hamilton, Cadwallader Drive, Trenton, N. J. 1937
Linsdale, Dr. J. M., Mus. of Vertebrate Zoology, Berkeley, Calif. 1921
Little, Dr. Clarence C., Bar Harbor, Maine 1927
Little, Luther, 2187 Roanoke Road, San Marino, Calif. ..... Charter
Lloyd, Hoyes, 582 Mariposa Ave., Rockcliffe Park, Ottawa, Canada ..... Charter
Locke, S. B., Izaak Walton League, 222 N. Bank Drive, Chicago, Ill. 1923
Long, Wilbur Stuart, 830 E. Platte Ave., Colorado Springs, Colo. 1936
Lonnberg, Einar, Prof. Dr. Naturvh. Riksm., Stockholm 50, Sweden ..... Charter
Loomis, Prof. F. B., 8 Orchard St., Amherst, Mass. 1926
Loring, John Alden, Owego, Tioga County, N. Y. ..... Charter
Lovell, Harvey B., Biology Dept., Univ. of Louisville, Louisville, Ky. 1934
Lowe, Prof. John N., Normal College, Marquette, Mich. 1925
Lower, L. O., 400 La Salle Station, Chicago, Ill. 1935
Lowery, George H., Louisiana State Univ., Baton Rouge, La. 1936
Lubicz-Niezabitowski, Prof. Dr. Edward, Universytet. Ul. Fredry 10, Posnam, Poland 1933
Luttringer, Leo A., Jr., Board of Game Commissioners, P. O. Bldg., Harrisburg, Pa. 1932
Lyon, Wm. I., 811 N. Sheridan Road, Waukegan, Ill. 1925
McBeath, Donald Y., 168 North St., Allegan, Mich. 1937
McBlain, Walter G., Jr., U. S. Fur Animal Exper. Sta., Saratoga, N. Y. 1930
McCabe, Francis R., 5714 S. E. 15th Ave., Portland, Oreg. 1937
McClain, Andrew W., Rt. 1, Box 72, Clovis, Calif. 1937
McClanahan, Robt. C., 1273 N. Hampshire Ave., N. W., Washington, D. C. 1937
McClintock, Norman, 144 Seventh Ave., Highland Park, New Brunswick, N. J. ..... Charter
McCullough, George W., 4858 Lyndale Ave., Minneapolis, Minn. 1937
McGregor, James H., Columbia Univ., New York City 1927
McIlhenny, Edward A., Avery Island, La. ..... Charter
McLain, Robert B., Box 132, Hollywood Sta., Los Angeles, Calif. ..... Charter
McMurray, Frank, Box 1433, Globe, Ariz. 1936
MacCoy, Clinton V., 1213 Beacon St., Brookline, Mass. 1930
MacLulich, Dr. Duncan A., Dept. of Pathology, Mountain Sanatorium, Hamilton, Ontario, Canada 1933
Macnamara, Charles, Arnprior, Ontario, Canada 1927
Madison, Harold L., Cleveland Mus. Nat. Hist., 2717 Euclid Ave., Cleveland, Ohio ..... Charter
Mailliard, Joseph, 1815 Vallejo St., San Francisco, Calif. ..... Charter

Malbrant, Dr. Vetre R., Chef du Service Zootechnique Brazzaville, Moyen Congo, Afrique Equitoriale, Francaise....1937
Manweiler, J., Resettlement Admin., Baudette, Minn....1936
Marcotte, Ptre M. L. Abbe Leon, Seminaire St. Charles, Sherbrooke, Canada....1925
Marden, Aaron S., Route 7, Augusta, Maine....1926
Marsh, Joel W., Division of Wildlife Research, Univ. of Maine, Orono, Maine....1937
Marshall, Robert, Office of Indian Affairs, Washington, D. C....1935
Marshall, W. H., Bear River Migratory Bird Refuge, Brigham City, Utah....1936
Mather, Deane W., 308 1st Ave. S. E., Little Falls, Minn....1930
Medcalf, Robert, 955 Edgecomb Place, Chicago, Ill....1937
Messer, Harold M., 300 Pearl St., Brooklyn, N. Y....1926
Metcalf, Prof. Z. P., North Carolina State College, Raleigh, N. C....Charter
Middleton, Dr. Austin R., Biol. Laboratories, Univ. of Louisville, Louisville, Ky....1921
Miller, Dr. Alden H., Mus. of Vertebrate Zoology, Berkeley, Calif....1930
Miller, Frederic W., 5434 Ridgedale Ave., Dallas, Tex....1920
Miller, Gerrit S., Jr., U. S. National Mus., Washington, D. C....Charter
Miller, Dr. Loye H., Univ. of California, Los Angeles, Calif....Charter
Miller, Richard G., College Campus, Principia College, Elsah, Ill....1936
Miller, Prof. Shirley P., Inst. of Anatomy, Univ. of Minn., Minneapolis, Minn....Charter
Mirguet, Joseph C., 449 Magnolia St., Rochester, N. Y....1928
Moffitt, James, 1879 Broadway, San Francisco, Calif....1929
Mohr, Carl Otto, Natural History Survey, Univ. of Illinois, Urbana, Ill....1927
Mohr, Charles E., 815 Greenwich St., Reading, Pa....1932
Mohr, Erna W., Zoologische Museum, Hamburg, Germany....1928
Monson, Gale, 311 East Green, Gallup, N. Mex....1935
Montgomery, Robt. D., Box 351, Baudette, Minn....1935
Moody, Dr. Paul A., Dept. of Zoology, William Science Hall, Burlington, Vt....1923
Moore, A. W., 673 E. Main St., Hillsboro, Oreg....1921
Moore, Robert T., R. R. No. 1, Box 28 A, Pasadena, Calif....1926
Morden, Wm. J., Amer. Mus. Nat. Hist., New York City....1925
Moree, Ray, Mus. Zoology, Ann Arbor, Mich....1936
Mori, Tamezo, Preparatory Dept., the Keijo Imperial Univ., Seoul, Corea....1927
Morse, Marius, E. C. W. Camp S-51, Brimson, Minn....1937
Morton, James N., 210 Hummel Ave., Lemoyne, Pa....1937
Mosby, Henry S., 413 Thompson St., Ann Arbor, Mich....1937
Moseley, Prof. E. L., State Univ., Bowling Green, Ohio....Charter
Mossman, Dr. Harland W., Science Hall, Univ. of Wis., Madison, Wis....1930
Moulthrop, Philip, The Cleveland Mus. Nat. Hist., Cleveland, Ohio....1936
Murdoch. Earle C., Soil Conservation Service, Urbana, Ill....1937
Murie, Dr. Adolph, Jackson, Wyo....1924
Murie, O. J., Jackson, Wyo....Charter
Murray, Prof. Joseph M., Dept. of Zoology, Univ. of Maine, Orono, Maine....1937
Murray, Dr. Leo T., Dept. of Biology, Baylor Univ., Waco, Tex....1936
Musgrave, Dr. John K., 350 Parkway Drive, Pittsburgh 16, Pa....1937
Nagel, Werner, Lefevre Hall, Columbia, Mo....1936
Necker, Walter L., 2001 North Clark St., Chicago, Ill....1936
Nelson, Arnold L., U. S. Biological Survey, Washington, D. C....1932
Nelson, Theodora, Dept. of Zoology, Univ. of Mich., Ann Arbor, Mich....1929
Netting, M. Graham, Carnegie Mus., Pittsburgh, Pa....1934
Newsom, Wm. M., 228 E. 61st St., New York City....1926
Nichol, A. A., College of Agriculture, Univ. of Arizona, Tucson, Ariz....1935
Nichols, David G., 116 9th St., Garden City, N. Y....1936

Nichols, John Treadwell, Amer. Mus. Nat. Hist., New York City.....Charter
Nicholson, A. J., Mus. of Zoology, Univ. of Michigan, Ann Arbor, Mich.....1935
Noble, Dr. G. K., Amer. Mus. Nat. Hist., New York City.....1926
Norton, Arthur H., Mus. of Nat. Hist., 22 Elm St., Portland, Maine.....Charter
O'Donoghue, Prof. Chas. H., Dept. of Zoology, Univ. of Edinburgh, Scotland..Charter
Oehser, Paul H., Smithsonian Inst., Washington, D. C.....1926
Ognev, Dr. S. I., Univ. Zoological Mus., Moscou, U.S.S.R.....1924
Okkelberg, Prof. Peter, 1220 Fair Oaks, Ann Arbor, Mich.....Charter
Olsen, Orange A., Forest Service, Ogden, Utah.....1935
Orange, Miss Jeanette, 1717 17th St., N. W., Washington, D. C.....1937
Orr, Dr. Robert T., Calif. Acad. of Sci., Golden Gate Park, San Francisco, Calif....1931
Orwoll, Harold S., Dept. of Zoology, Mich. State College, East Lansing, Mich..1937
Osborn, Chase S., Homestead P. O., Chippewa County, Mich.....1925
Osgood, Frederick L., Jr., 17 Charles St., Rutland, Vt.....1933
Ostenson, Burton T., Dept. of Zoology, Mich. State College, East Lansing, Mich...1933
Owen, Keith, Davis Gardens, P. O. Box 783, Terre Haute, Ind.....1933
Pack, Arthur Newton, American Nature Association, Washington, D. C.....1929
Palmer, Dr. E. Laurence, Fernow Hall, Ithaca, N. Y.....1927
Palmer, Fletcher G., C/o Mus. of Vertebrate Zoology, Berkeley, Calif.....1935
Palmer, L. J., Rocky Mt. Forest & Range Exper. Sta., Fort Collins, Colo.....1927
Palmer, Dr. T. S., 1939 Biltmore St., N. W., Washington, D. C.....Charter
Parker, Dr. Geo. H., 16 Berkeley St., Cambridge, Mass.....Charter
Parker, Harry C., Mus. of Natural History, Worcester, Mass.....1927
Parker, Wesley D., Sullys Hill Nat'l. Preserve, Ft. Totten, N. Dak.....1926
Pearce, John, N. E. Forest Exper. Sta., 335 Prospect St., New Haven, Conn.....1931
Perkins, Prof. E. H., Colby College, Waterville, Maine.....1922
Peters, James L., Lane End. Harvard, Mass.....Charter
Pettingill, Dr. O. S., Jr., Dept. of Zoology, Carlton College, Northfield, Minn.....1936
Phillips, Frank, C/o F. P. Ranch, Route 4, Bartlesville, Okla.....1926
Phillips, John M., 2227 Jane St., Pittsburgh, Pa.....Charter
Phillips, Paul G., Box 1051, Gallup, N. Mex.....1936
Phinizy, Dr. Irvine, 2330 Kings Way, Augusta, Ga.....1936
Pickwell, Dr. Gayle B., State Teachers College, San Jose, Calif.....1926
Ping, Dr. Chi, Biol. Laboratory, Science Society of China, Nanking, China.....1931
Pirnie, Dr. Miles D., W. K. Kellogg Bird Sanctuary, Augusta, Mich.....1928
Pohle, Dr. Hermann, Zoologisches Museum, Invalidenstrasse 43, Berlin, N. 4, Germany.....1928
Poole, E. L., Reading Public Mus., Reading, Pa.....1922
Porro, Thomas J., 718 Medical Arts Bldg., Tacoma, Wash.....1931
Preble, Edward A., 3027 Newark St., N. W., Washington, D. C.....Charter
Preble, Norman A., 73 Prospect St., Wakefield, Mass.....1935
Presnall, Clifford C., Zion National Park, Utah.....1935
Quaintance, Charles W., Mus. of Vertebrate Zoology, Berkeley, Calif.....1935
Ramsden, Dr. Charles Theodore, 8 y 19; Vista Alegre, Santiago de Cuba, Cuba.Charter
Rand, Dr. A. L., Amer. Mus. Nat. Hist., New York City.....1933
Rasmussen, D. Irvin, U. S. Biological Survey, Utah State Agric. College, Logan, Utah.....1936
Raven, Henry C., Amer. Mus. Nat. Hist., New York City.....Charter
Raynes, George W., 209 Miller Ave., Portsmouth, N. H.....1926
Reeves, Mark W., Stockade, Clinton, Conn.....1928
Rehn, James A. G., Acad. of Natural Sciences, Philadelphia, Pa.....Charter
Rett, Egmont Z., Santa Barbara Mus. Nat. Hist., Santa Barbara, Calif.....1924

Richardson, Wm. B., R. 2, Box 1170, Porterville, Calif.....1933
Richter, Dr. Curt P., Psychological Lab., Johns Hopkins Hospital, Baltimore, Md..1924
Ridsdale, P. S., 1214 16th St., N. W., Washington, D. C.....1926
Riemer, Julius, Berlinerstrasse, 163, Berlin-Tempelhof, Germany.....1930
Riley, J. H., U. S. National Mus., Washington, D. C.....Charter
Ritter, Dr. Wm. E., Dept. Zoology, Univ. of Calif., Berkeley, Calif.....1926
Roberts, Austin, Transvaal Mus., P. O. Box 413, Pretoria, South Africa.....Charter
Roberts, Howard R., Villa Nova, Pa.....1925
Roberts, Dr. T. S., Zoological Mus., Univ. of Minnesota, Minneapolis, Minn...Charter
Robertson, Howard, 157 Wilton Drive, Los Angeles, Calif.....Charter
Robinson, James B., 217 Seward Place, Schenectady, N. Y.....1923
Rogers, Albert C., Colo. Mus. Nat. Hist., City Park, Denver, Colo.....Charter
Roosevelt, Kermit, 1 Broadway, New York City.....Charter
Roosevelt, Theodore, Jr., Oyster Bay, Long Island, N. Y.....1925
Rose, Robert H., Southwestern National Monuments, Coolidge, Ariz.....1933
Ross, Roland C., 1820 Bushnell Ave., S. Pasadena, Calif.....1935
Rowan, Prof. Wm., Univ. of Alberta, Edmonton, Alberta, Canada.....1921
Rowley, J. Stuart, 424 N. Valencia St., Alhambra, Calif.....1928
Ruhe, Dr. Hermann, 853 Broadway, New York City.....1930
Ruhl, H. D., Game Division, Dept. of Conservation, Lansing, Mich.....1928
Rusconi, Carlos, Garay 3818, Buenos Aires, Argentina.....1933
Rush, W. M., C/o U. S. Biological Survey, 404 U. S. Court House, Portland, Ore...1925
Russell, Dr. C. P., National Park Service, Washington, D. C.....1931
Russell, Ward C., Mus. of Vertebrate Zoology, Berkeley, Calif.....1931
Rust, Henry B., II, Rust Eng. Co., 1127 Martin Bldg., Birmingham, Ala.....1936
Rust, Henry J., Box 683, Coeur d'Alene, Idaho.....1922
Sage, Dean, Jr., Llewellyn Park, Orange, N. J.....1933
Salyer, J. Clark, II, U. S. Biological Survey, Washington, D. C.....1935
Sanborn, Colin C., Field Mus. Natl. Hist., Chicago, Ill.....1924
Sanderson, Wilford E., 80 Howard St., Albany, N. Y.....1927
Sans, Edward R., Box 805, Reno, Nev.....Charter
Santens, R. H., Carnegie Mus., Pittsburgh, Pa.....1934
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Sawyer, Dr. Elizabeth L., Lefevre Hall, Columbia, Mo.....1936
Sayles, E. Duane, Virginia Junior College, Virginia, Minn.....1931
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Schlatter, E. B., Jr., Resettlement Adminstr., Big Falls, Minn.....1937
Schmidt, Karl P., Field Mus. of Natural History, Chicago, Ill.....1925
Schnell, Frank, Jr., 904 Brown Ave., Columbus, Ga.....1934
Schorger, A. W., 168 N. Prospect Ave., Madison, Wis.....1924
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Schultz, Dr. C. Bertrand, Nebr. State Mus., Univ. of Nebr., Lincoln, Nebr.....1933
Schultz, Edith C., 2 Edgewood Road, Scarsdale, N. Y.....1930
Schwarz, Max. D., 625 Tuxedo Blvd., Webster Groves, Mo.....1934
Scott, Prof. John W., Univ. of Wyoming, Laramie, Wyo.....1925
Scott, Thos. G., Extension Service, Ames, Iowa.....1937

Scott, Walter E., Conservation Dept., Madison, Wis. 1937
Scott, Walter J., Swarthmore College, Swarthmore, Pa. 1933
Sefton, Joseph W., Jr., 638 F. St., San Diego, Calif. 1925
Seghetti, Libero, Eatonville, Wash. 1936
Selle, Dr. Raymond M., Occidental College, Los Angeles, Calif. 1928
Seton, Henry, Mus. Comp. Zool., Harvard Univ., Cambridge, Mass. 1924
Shadle, Prof. Albert R., Univ. of Buffalo, Buffalo, N. Y. 1925
Shamel, H. Harold, U. S. National Mus., Washington, D. C. 1923
Sharp, Dr. Ward M., Valentine Lakes Refuge, Valentine, Nebr. 1936
Shaw, Dr. William T., 1002 Cambridge Ave., Fresno, Calif. ..... Charter
Shearer, Dr. Amon R., Mont Belvieu, Tex. 1923
Sheldon, Carolyn, Woodstock, Vt. 1930
Sheldon, Harry H., 269 Cold Springs Road, Santa Barbara, Calif. ..... Charter
Sheldon, William G., R. F. D. No. 1, Woodstock, Vt. 1933
Shelford, Dr. Victor E., Vivarium Bldg., Wright & Healey St., Champaign, Ill. 1923
Sheppard, Walter B., 1060 Gaylord St., Denver, Colo. 1929
Sherman, Dr. Harley B., R. F. D. No. 2, Gainesville, Fla. ..... Charter
Siegler, Hilbert R., Box 30, Huntsville, Tex. 1937
Silliman, O. P., Alisal & Riker Sts., Salinas, Calif. 1924
Silver, James, U. S. Biological Survey, Washington, D. C. ..... Charter
Sime, Palmer, Dept. of Forestry, Conn. State College, Storrs, Conn. 1936
Simpson, Dr. George G., Amer. Mus. Nat. Hist., New York City 1928
Skillen, Dr. Don R., Route 1, Box 65, Pasadena, Calif. 1933
Skinner, M. P., 1316 Harding St., Long Beach, Calif. ..... Charter
Smiley, A. K., Jr., Mohonk Lake, N. Y. 1932
Smiley, Daniel, Jr., Mohonk Lake, N. Y. 1931
Smiley, Dwight C., Mus. of Vertebrate Zoology, Berkeley, Calif. 1936
Smith, Austin P., Zarcero, Costa Rica ..... Charter
Smith, Clarence F., U. S. Biological Survey, Washington, D. C. 1936
Smith, Horace G., 2918 Lafayette Street, Denver, Colo. ..... Charter
Smith, Laurence H., Soil Conservation Service, Moscow, Idaho 1936
Smith, Dr. Philip W., 2331 S. Salina St., Syracuse, N. Y. 1935
Smith, Wendell P., Wells River, Vt. 1927
Snyder, L. L., Royal Ontario Mus., Toronto, Ontario, Canada 1921
Soper, J. Dewey, 827 Riverwood Ave., Winnipeg, Manitoba, Canada ..... Charter
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Spalding, Edward L., Kappa Sigma, Orono, Maine 1937
Spalding, Irwin, P. O. Box 2787, Honolulu, T. H. 1928
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Spencer, Donald A., 3245 Perry St., Denver, Colo. 1928
Sperry, Prof. Arthur B., Kansas State Agric. College, Manhattan, Kans. 1923
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Spiker, Chas. J., Branchport, N. Y. 1935
Sprague, Jas. M., Mus. of Birds & Mammals, Univ. of Kansas, Lawrence, Kans. 1937
Springer, Stewart, Bass Biological Laboratory, Englewood, Fla. 1936
Sprinkle, Chas. Roger, Conrad, Mont. 1937
Stager, Kenneth, 4300 Budlong Avenue, Los Angeles, Calif. 1936
Stanford, J. S., Utah State Agric. College, Logan, Utah 1931
Stebler, Adolph M., Dept. of Conservation, Lansing, Mich. 1933
Steenberg, Prof. Dr. Carl M., Silene Alle 9, Copenhagen-Soborg, Denmark 1929
Stegeman, Dr. LeRoy C., New York State Coll. of Forestry, Syracuse, N. Y. 1929
Stephan, Jos. A., 30 Erkenbrechu Ave., Cincinnati, Ohio 1935

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Stewart, Philip B., 1228 Wood Ave., Colorado Springs, Colo.....1921
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Stock, Dr. Chester, California Inst. of Technology, Pasadena, Calif.....Charter
Stoddard, Herbert L., The Hall, Route 1, Tallahassee, Fla.....Charter
Stone, Harry Herbert, P. O. Box 101, Sturbridge, Mass.....1926
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Stoner, Dr. Dayton, New York State Mus., Albany, N. Y.....Charter
Storer, Robt. W., 522 Vose Ave., South Orange, N. J.....1937
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Stout, Thompson M., Morrill Hall, Nebraska State Mus., Lincoln, Nebr.....1934
Straus, Dr. William L., Jr., Dept. of Anatomy, Johns Hopkins Medical School, Baltimore, Md.....1925
Stray, Joseph W., 134–136 Broadway, Brooklyn, N. Y.....1924
Streator, Clark P., 229 Otus St., Santa Cruz, Calif.....Charter
Stryker, Carol, 640 Broadway, West New Brighton, Staten Island, N. Y.....1935
Stupka, Arthur, Great Smoky Mountains National Park, Gatlinburg, Tenn.....1935
Sumner, E. L., Jr., P. O. Box 188, Menlo Park, Calif.....1926
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Suter, Estes, Wind River National Park, Hot Springs, S. Dak.....1936
Svihla, Dr. Arthur, Zool. Dept., State College of Wash., Pullman, Wash.....1926
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Swanson, Carl V., R. F. D. No. 1, Pasco, Wash.....1936
Swanson, Gustav, Coburn Hall, Univ. of Maine, Orono, Maine.....1935
Swenk, Myron H., 1410 North 37th St., Lincoln, Nebr.....Charter
Swindle, Dr. Percy F., 561 N. 15th St., Milwaukee, Wis.....1927
Sykes, Prof. G. F., 416 Huntington Ave., Boston, Mass.....1935
Tanner, Prof. Vasco M., Brigham Young Univ., Provo, Utah.....Charter
Tappe, Donald T., R. R. No. 1, Box 450, Porterville, Calif.....1936
Tate, George H. H., Amer. Mus. Nat. Hist., New York City.....1924
Taylor, Dr. E. H., Dept. of Zoology, Univ. of Kansas, Lawrence, Kans.....1924
Taylor, Dr. W. P., Faculty Exchange, Texas Agric. & Mech. College, College Station, Tex.....Charter
Terres, J. Kenneth, U. S. Soil Conservation Service, Norwick, N. Y.....1935
Test, Frederick H., 511 Russell St., W. Lafayette, Ind.....1930
Thompson, Ben H., Wildlife Division, National Park Service, Washington, D. C.....1935
Thone, Dr. Frank, Science Service, Washington, D. C.....1932
Thorpe, Dr. Malcolm R., Peabody Mus. Nat. Hist., Yale Univ., New Haven, Conn.....1921
Todd, Dr. T. Wingate, Western Reserve Medical School, Cleveland, Ohio.....Charter
Tokuta, Mitoshi, C/o Zool. Inst., College of Science, Kyoto Imperial Univ., Kyoto, Japan.....1934
Tomkins, Ivan R., U. S. Dredge "Welatka," Savannah, Ga.....1930
Tout, Wilson, North Platte, Nebr.....1926
Townsend, Dr. C. H., New York Aquarium, Battery Park, New York City.....1930
Townsend, Dr. M. T., Illinois Wesleyan Univ., Bloomington, Ill.....1928
Trost, Henry J., M. H. DeYoung Memorial Mus., Golden Gate Park, San Francisco, Calif.....1926
Trowbridge, Albert H., Dept. of Zoology, Univ. of Okla., Norman, Okla.....1937
Tubbs, Farley F., Game Division, Dept. of Conservation, Lansing, Mich.....1935
Turov, Prof. S., Zoological Mus., Moscou Univ., Moscou, 9, Herzen St. 6, U.S.S.R.....1930
Uhler, Francis Morey, U. S. Biological Survey, Washington, D. C.....1926

Vanderhoof, Dr. V. L., 301 Hearst Mining Bldg., Berkeley, Calif.....1936
Van Tyne, Dr. Josselyn, Univ. Mus., Ann Arbor, Mich.....1924
Van Vleet, George, Jr., Wash. State College, Pullman, Wash.....1934
Versluys, Dr. Jan, Grinzingerallee 18, Wien 19, Austria.....1930
Vestal, Elden Hall, 341 23rd St., Richmond, Calif.....1936
Vogt, Edward, 57 Albert Ave., Buffalo, N. Y.....1936
Von Bloeker, Jack C., Jr., Mus. of Vertebrate Zoology, Berkeley, Calif.....1927
Vorhies, Dr. Charles T., Univ. of Arizona, Tucson, Ariz.....Charter
Vrtis, Dr. Vlastimil, Prazska 69, Brno, Czechoslovakia.....1932
Wade, Dr. Otis, Bessey Hall, State Univ., Lincoln, Nebr.....1926
Wagner, Laverne G., 36 Erie St., Lancaster, N. Y.....1934
Walker, Alex., Route A, Box 267, Tillamook, Oreg.....1920
Walker, Ernest P., Apt. 103, 3016 Tilden St., N. W., Washington, D. C.....Charter
Walton, Philip C., 21 Gilmore Ave., Merchantville, N. J.....1937
Warfel, Prof. H. E., State College, Amherst, Mass.....1935
Warmbath, Julian S., U. S. National Mus., Washington, D. C.....Charter
Warren, Edward R., 1511 Wood Ave., Colorado Springs, Colo.....Charter
Warthin, Prof. Alfred S., Jr., N. E. Bldg., Vassar College, Poughkeepsie, N. Y.....1926
Way, Ivan M., Dept. of Anatomy, Univ. of Colo. School of Medicine, Denver, Colo..1926
Webb, William L., Division of Economic Zoology, Univ. of Minn., St. Paul, Minn...1937
Weed, Prof. Lewis H., Dept. of Anatomy, Johns Hopkins Medical School, Baltimore, Md.....1921
Wetherill, Milton A., Box 81, Flagstaff, Ariz.....1937
Weydemeyer, Winton W., Fortine, Mont.....1927
Whitaker, H. L., Soil Conservation Service, United Life Bldg., Salina, Kans.....1934
White, James S., 284 Beech St., Highland Park, Ill.....1931
White, Theodore E., Mus. of Comparative Zoology, Cambridge, Mass.....1926
Whitney, Prof. Alvin G., New York State Mus., Albany, N. Y.....Charter
Wight, Prof. H. M., 1417 S. University Ave., Ann Arbor, Mich.....1921
Willett, G., Los Angeles Mus., Exposition Park, Los Angeles, Calif.....1935
Williams, Cecil S., Bear River Migratory Bird Refuge, Brigham City, Utah.....1936
Williams, Coleman S., Saugatuck, Conn.....1930
Wilson, Mrs. Beryl M., Box 128, Davis, Calif.....1930
Wilson, Dr. Robert Warren, 220 N. Ave. 57, Los Angeles, Calif.....1933
Winton, Prof. W. M., Texas Christian Univ., Fort Worth, Tex.....1922
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Yeager, Lee E., School of Forestry and Conservation, Univ. of Mich., Ann Arbor, Mich.....1937
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Young, Charles H., National Mus. of Can., Ottawa, Canada.....1922
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Zahniser, Howard, 3220 Connecticut Ave., Washington, D. C.....1935
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Zimmerman, Fred R., Central Wisconsin Game Proj. Site II, Box 102, Black River Falls, Wis.....1936

NOTICE OF ANNUAL MEETING

The twentieth annual meeting of the American Society of Mammalogists will be held in Berkeley and San Francisco, California, from Tuesday, July 19, to Saturday, July 23, 1938.

The Local Committee on Arrangements comprise: E. Raymond Hall, Chairman, Seth B. Benson, Emmet T. Hooper, Robert T. Orr, Reuben A. Stirton.

Notice of the meeting, with further details as they become available, will appear in each forthcoming number of the JOURNAL, for the benefit of those who wish to plan well ahead for attendance, and in the hope that a large number of eastern members will be present.

Seton's
LIVES OF GAME ANIMALS

Through an arrangement with the publishers, the new edition of Seton's LIVES OF GAME ANIMALS, in a four volume set, is now available to members of the Society at the reduced price of $12.00, delivered. The text is the same as in the eight volume set of the previous edition. Orders should be sent to the Corresponding Secretary.

Back volumes of the Journal of Mammalogy *are still available as follows:*

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Vol. 7. (1926) to Vol. 17. (1937), each	4.00

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1. **Anatomy of the Wood Rat**, by A. Brazier Howell (out of print)

Members are allowed a discount of 8 per cent.

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177 pages, 78 halftones and diagrams.

3. **Animal Life of the Carlsbad Cavern**, by Vernon Bailey....$1.00

192 pages, 66 halftones, 2 maps, 1 colored.

William H. Burt, *Corresponding Secretary*
Museum of Zoology, University of Michigan, Ann Arbor, Mich.

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